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Passenger and cargo demand time-series analysis for better aircraft capacity utilization of Lufthansa/Lufthansa Cargo at Saint Petersburg airport

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Abstract

Lufthansa Cargo (LCAG) was a subsidiary company of Lufthansa (LH) which carried out the cargo business for it. LCAG had a lot of stations around the world which manage cargo handling. One of those stations was situated in Saint Petersburg (LED).

For the moment of study, LCAG at LED had only 7.29% of cargo transported imported and exported to and from Cargo Terminal Pulkovo (CTP) while LCAG's competitor airlines and the leader in all freight transported through the same cargo terminal owned the share of 37.44%. The major reason for this was accounted to be that competitors' fleet had a greater capacity, so more load with the greater dimensions could be carried. Those competitor airlines were using wide-body aircrafts (WB a/c) for the LED station while LH had only narrow-body aircrafts (NB a/c) employed in its turnarounds. This had given LH restrictions to carry bigger loads due to smaller capacity.

Therefore, time-series analysis of the LH and LCAG passenger and cargo historical data was made to forecast future passenger and cargo demands. According to the predicted demands, the a/c fleet assignment was done in order to see whether there was any need for change which would result in better capacity planning and, subsequently, in larger amount of revenues.

The proposed option states that a/c change, from NB to WB, was only applicable during operation under summer schedule (June-August) and on the route FRA-LED-FRA in the morning. The respective outcomes showed a number of pros and cons regarding the final decision. However, the precautions and suggestions for the future studies were revealed and brought out.

Keywords/tags (subjects)

Time-series analysis, airline business, passenger demand, air cargo demand, capacity utilization, fleet assignment

Miscellaneous (Confidential information)

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1 Introduction

Air cargo creates a considerable amount of revenues for an airline. In 2017, world-wide air cargo revenue reached $100.2 billion while $36.3 billion was received by combination or full-service carriers (FSCs) (Boeing 2018, 7). What is more, 2017 was accounted to be very optimistic year for airline industry in terms of cargo transport, meaning that air cargo traffic has risen by 10.1% while the average growth of it was accounted to be 4.2% annually (ibid., 4). With such a positive trend, air cargo is aiming at generating even more revenues. This states a reason to revise the capacity of airline's fleet as more freight is planned to be transported. Most of the freight is moved with FSCs or combination carriers which are providing transport service for passengers and air cargo on the same board.

What is crucial to outline is that while this thesis is going to address mainly air cargo segment in airline business, the passenger side of it has to be taken into consideration as well. In fact, FSC's major amount of revenues comes from passenger transportation (84.8%) while air cargo shares of revenues for the same airline account 15.2%. When those figures are compared, it is obvious to say that the difference between the two is vast. Sometimes it is the cargo transport which secures combination airlines from making losses. If there are not enough revenues received from passengers, cargo will save the day.

In that sense, air cargo business for an airline is highly important. In order to create greater revenues, optimal fleet should be chosen for operations. "Optimal" fleet stands for a particular aircraft (a/c) type choice to be made to fit a demand considering the whole rotation of an a/c (Belobaba, Odoni, & Barnhart 2015, 598y). Airline's planning process includes the problem of fleet planning, assignment and scheduling. This problem is reflected as one of the toughest and the most demanding parts of airlines planning process. When the proper a/c is assigned to Origin-Destination (O-D) route, the costs can be significantly minimized while the revenues will be maximized. Therefore, more profit can be achieved.

Thus, to choose the best a/c type, offered capacity needs to meet air cargo demand. Besides, as it has been already mentioned, FSC's main business is concentrated on

passenger transportation, so the demand of this particular side has to be considered. Following to Xie, Wang and Lai (2014, 20—26), the most important task of an airline is to construct as accurate and precise forecast as possible in order to plan further operations.

Therefore, this thesis represents the analysis and forecast of demand figures regarding, primarily, air cargo and, subsequently, passenger transport of Lufthansa (LH)/Lufthansa Cargo (LCAG) at Saint Petersburg's station (LED). The analysis will result in an appropriate a/c model solution proposal with the respective pros and cons discussed.

The rest of this thesis study is structured as follows. Firstly, as usual, the problem is going to be described in order to make the reader of the current thesis understand the issue which is going to be addressed and solved (see chapter 1.1). Chapter 1.2 is planned to set the boundaries for the study, and chapter 1.3 shortly describes the research methods applied with the proceeding of the current thesis.

Chapter 2 includes the list of abbreviations related to this research.

Chapter 3 refers to the theoretical base for the study where:

- Chapter 3.1 points out the previous results regarding the same or closely related research topics;
- Chapter 3.2 provides a reader with the overall picture and understanding of airline business
- Chapter 3.3 covers the trends for Lufthansa and Lufthansa Cargo globally, and, in closure of the current chapter;
- Chapter 3.4 explains the methodology used for further study execution.

The practical matters of the current study start from chapter 4. Air cargo market at LED and its demand with the respective forecast are handled in chapters 4.1 and 4.2. Air passenger market at LED is analyzed the same way in chapters 4.3 and 4.4. As the main objective is to find the most suitable type of a/c for LH/LCAG at LED, the existing fleet (chapter 4.5) and local schedule (chapter 4.6) are taken into account for the further conclusions made-up. Chapter 4.7 presents the option to be proposed to an airline considering all mentioned above. Subsequently, advantages and disadvantages are observed, studied and explained in subchapter along with financial benefits and losses in chapter 4.8.

Finally, chapter 5 summarizes the results obtained throughout the study: providing the answers on research questions (chapter 5.1) and giving suggestions for the future studies regarding the same topic (chapter 5.2).

Additionally, chapter 6 includes appendices related to the current thesis as well as chapter 7 lists all the references used for thesis's implementation.

1.1 Aim and objective

This chapter is going to cover the main aim and objectives of the current thesis work.

It should primarily be decided what is going to be achieved. Therefore, the aim is going to be presented with the objectives. The key purpose of it is to see whether the obtained results work along with the idea of the thesis.

[redacted]Thesis goal

The primary goal is to propose the "optimal" aircraft fleet assignment for Lufthansa/Lufthansa Cargo station in Saint Petersburg (LED) by fulfilling the set objectives.

[redacted]Thesis objectives

The set objectives of the current thesis are as following:

- Profit increase;
- Positive local market share growth;
- Other valuable and weighty advantages.

To achieve the above-mentioned objectives, several crucial stages have to be fulfilled. These steps are presented below:

1. To construct as accurate passenger demand forecast as possible;
2. To construct as accurate air cargo demand forecast as possible;
3. To study thoroughly the present schedule at LED;
4. To analyze the existing fleet at LED;
5. To provide clearly explained advantages and disadvantages.

Research questions

To conclude whether the results of this thesis are matching the set objectives, the following questions have to be answered:

1. What aircraft fleet assignment can be applied for Lufthansa/Lufthansa Cargo in Saint Petersburg (LED)?
2. What flight frequency should be applied be at LED?
3. What are advantages and disadvantages of the proposed fleet assignment?

1.2 Research limits

The proposed solution is going to be aimed on:

- LH's Saint Petersburg station (LED);
- Import and export flight schedule at LED.

Due to information limitation, only following data is used for study and conclusions derivations:

- Export/import air cargo statistics for Lufthansa Cargo (LCAG) at LED (2016-2018) on a monthly basis;
- Export/import are cargo statistics for Cargo Terminal Pulkovo (CTP) at LED (2017-2018) on a monthly basis;
- Export/import passenger statistics for Lufthansa (LH) at LED (2016-2018) on a monthly basis.

Due to time limitation, only following study is going to be provided:

- Air cargo analysis (LED) and forecast for 2019;
- Passenger analysis (LED) and forecast for 2019;
- Fleet configuration analysis and proposal;
- Cost and revenues calculation on the best option fitted for LCAG at LED.

1.3 Research methods

This thesis is going to be followed by quantitative method. Quantitative results will come from statistics analysis carried out by time-series analysis.

The clear explanation is presented later in the current thesis in the chapter 3.4. In that chapter, methodology with the defined steps for the study is discussed.

The research is based mainly on literature review, textbooks, scientific articles, academic journals, data provided by LCAG and CTP and Intranet E-base of LH/LCAG.

2 List of abbreviations

A/C – Aircraft

(A)FTK – (Available) Freight Tonne-Kilometer

(A)MTK – (Available) Mail Tonne-Kilometer

ARIMA – Autoregressive Integrated Moving Average

(A)SK – (Available) Seat-Kilometer

(A)TK – (Available) Tonne-Kilometer (passenger and cargo)

ATM – Aircraft Type Manual

CMA – Centered Moving Average

CTP – Cargo Terminal Pulkovo

CWT – Chargeable Weight

DCA – Data Characteristic Analysis

DME – Domodedovo/Airport code for Moscow

DOC – Direct Operating Costs

DXB – Airport code for Dubai

FRA – Airport code for Frankfurt

FSC – Full-Service Carrier

GARCH – Generalized Autoregressive Conditional Heteroskedasticity

GDP – Gross Domestic Product

H&S – Hub and Spoke network

HSR – High-Speed Rail

HVTS – High Value Time Sensitive

IOC – Indirect Operating Costs

LCAG – Lufthansa Cargo

LED – Airport code for Saint Petersburg

LF – Load Factor

LH – Lufthansa

MAD – Mean Absolute Deviation

MAPE – Mean Absolute Percentage Error

MOW – City code for Moscow

MUC – Airport code for Munich

O – D – Origin – Destination

PAX – Air Passenger

PPP – Private Partnership Agreement

R(F)TK – Revenue (Freight) Tonne-Kilometer

RPK – Revenue Passenger-Kilometer

RTK – Revenue Tonne-Kilometer (passenger and cargo)

SARIMA – Seasonal Autoregressive Integrated Moving Average

SGHA – Standard Ground Handling Agreement

SLR – Simple Linear Regression

SMA – Simple Moving Average

SVR – Support Vector Regression

TVP – Time-Varying Parameter

ULD – Unit Load Device

3 Theoretical background

3.1 Previous study

Many industries are taking advantage of demand forecasting to predict different types of variations: sales in pharmaceutical supply chains (Merkuryeva, Valberga & Smirnov 2019, 3—10), visitor demand in restaurant business (Tanizaki, Hoshino, Shimmura &Takenaka 2019, 679—683), natural gas distribution (Hribar, Potočnik Šilc & Papa 2019, 511—522), demand in tourism sector (Song, Qiu & Park 2019, 338—362), water supply-demand figures (Vijai & Sivakumar 2018, 258—266; Sardinha-Lourenço, Andrade-Campos, Antunes & Oliveira 2018, 392—404; Lopez Farias, Puig, Rodriguez Rangel, & Flores 2018, 660—680), energy industry (Chen, Rao, Liu, Chen & Liao 2019, 396—403; Tarsitano & Amerise 2017, 108—114; Akpinar & Yumusak 2016, 727—743) and production planning (Matsumoto & Komatsu 2015, 161—175).

Nonetheless, transportation industry is also benefiting in conduction demand forecasts. The variety of demand analysis and forecasting methods were used in every single mode of transport starting from solely mode and ending with multimodality. For instance, container throughput demand in maritime logistics was analyzed by autoregressive distributed lag model with economic scenarios (Rashed, Meersman, Sys, Van de Voorde & Vanelslander 2018, 127—141). The similar problem was addressed by Xie, Zhang and Wang (2017, 160—178) by proposing he forecast for container throughput with Data Characteristic Analysis (DCA) so that the better performance can be achieved. Besides, maritime cargo demand forecast was proposed in the study of Tu, Adiputranto, Fu and Li (2018, 108—125) to develop shipping network for hubs and international gateways.

Börjesson (2014, 81—92) carried out a passenger demand forecast for High-Speed Rail (HSR) by using aggregate data. Afterwards, Chou, Shen, Gao, Gao, Wang and Tsai (2018, 1151) conducted a research where time-series analysis was utilized in order to introduce the passenger demand in a regional transport market.

Apart from passenger demand forecasting in rail transport, some cargo demand was analyzed as well but already in road transport sector. Trofimova and Borodulina (2017, 195—205) presented a forecasting model which allowed to predict and calculate regional cargo volumes.

Again passenger demand was examined but in multimodal transport. Haar and Theissing (2016, 49—69) introduced a stochastic hybrid automaton model. This model made it possible to forecast load factors which enable to come up with the appropriate strategy for the future.

There is one more mode of transport which is left behind till this point of discussion – air transport – the main topic of the current thesis. Air cargo has been received a great attention in aviation industry. A lot of methods were used for optimizing air cargo transport addressing the existing problem from different angles. According to Nahum, Hadas and Kalish (2019, 354—361), Armacost, Barnhart, Ware and Wilson (2004, 15—25) proposed the model for a number of shipments that are planned to be transported by cargo planes with minimal capacity and with consideration of delivery times. In Nahum, Hadas and Kalish (2019, 354—361) work, Drexl and Nikulin (2008, 385—397) tried to solve the air cargo transport problem from an airport perspective while coming up with the most efficient and effective cargo loading.

Only few researchers studied air cargo transportation traffic by addressing to demand component while there are plenty of works when passenger demand was analyzed and forecasted with the future perspective. Time-series analysis was given a preference when studying and forecasting demand fluctuations. Mostly, autoregressive models were constructed to observe the trends in air passenger traffic and to provide the most reliable forecasts. For example, Autoregressive Integrated Moving Average (ARIMA) approach was chosen by Pitfield (2008, 113—122) to determine the impact of passenger demand on traffic and market share in the US. The author takes the routes to be considered. The results are lately compared to the previous study carried out for Ryanair operations.

FIldes, Wei and Ismail (2011, 902—922) examined short- and medium-term air traffic flows with the help of autoregression models and time-varying parameter (TVP) models. As the article aims for comparison of various forecasting methods applied to air passenger traffic flow, the study concluded that autoregression models are more

accurate than TVP models.

Seasonal data of air passenger traffic were assessed with time-series analysis utilizing the same regression method used by Pitfield (2008, 113—122) in Lazar, Sedláčková and Bréda's work (2015, 228—232). The outcomes of the study show the dependence between previous demand and forecasted ones according to the method applied.

Passenger and flight volume forecasts at German airports for 2016—2018 were presented by using regression method as well. In order to build up more precise forecast, the model used included demand errors and estimated GDP variations. (Gelhausen, Berster & Wilken 2018, 1401—52.)

ARIMA + GARCH + Bootstrap time-series method combination was applied to forecast air passenger demand. This approach included historical passenger demand data, its trends and variations. (Nieto & Carmona-Benítez 2018, 1—8.)

Only a few authors look into the problem from both parts of airline business. As an example, time-series are again employed in the study of Pehlivanoglu and Atik (2016, 23—33) to analyze both air cargo and passenger traffic flows in Turkey. The estimated results showed a significant increase in passenger and cargo volumes from 2016 to 2020. Then, Xu, Chan and Zhang (2018, 169—180) used hybrid time-series SARIMA-SVR approach in order to forecast demand for statistical indicators like passenger and cargo demands in airline industry. The forecast presented was later used in capacity planning.

It is clearly seen that time-series analysis is widely used to create forecasts in different industries, especially in aviation. Therefore, the same method is going to be used in the current study due to previous results' reliability. Later on, capacity planning and fleet assignment problem will be discussed based on the obtained air cargo and passenger forecasts.

3.2 Background research: The global airline industry

Importance of aviation cannot be underestimated, and, in the era of connections, aviation business steps forward with its meaning for the world. Distances become shorter, not literally but figuratively, in terms of time consumption. A person can be

in the other part of the world in a matter of several hours. Specific cargo like time-sensitive goods (i.e. food supplies) or valuable shipments (i.e. golden bars), which should be transported immediately, needs as fast transportation as possible. Nowadays, to conduct a successful business, proactive responses and solutions should be provided. Therefore, the use of transportation by air comes in handy.

Looking at the global airline industry, it is pointless to outline its scope simply because this fact is obvious. There are different modes of transport, and air transportation is on the list of the main ones. Besides, more and more countries are becoming capable of integrating with each other with the help of new market establishments and airline business development.

New market openings provide airline industry with more considerable opportunities for enhancing already existing services. Transport service includes movements of people and cargo. Therefore, the upcoming chapters mean to discuss separately two sides of aviation business and their trends in general: air cargo and passenger businesses. (Benito & Alonso 2018, 21—23.)

[redacted]Air cargo business definition

Air cargo industry covers the movement of goods of various sizes and commodities by air but mostly valuable ones. Cargo is divided into three groups: air freight, mail, and passenger baggage (Belobaba et al. 2015, 397q). Freight usually represent general cargo or special cargo commodity (express, diplomatic bags, etc.) while mail includes post, letters or parcels. Passenger baggage is associated with personal goods which are carried along with the passenger flying the same flight. (ICAO Glossary 2019, 6.)

High-value-time-sensitive (HVTS) goods, which usually give their preference to air transport, are primarily moved by air. These goods represent the fastest-growing trade commodity in the world. Whether it is valuable or perishable cargo, there is a need in as urgent and fast transportation as possible. Valuable cargo is vulnerable to theft, perishables tend to expire in a certain period of time. (Sales 2016, 113—114.)

Moreover, rapid cargo transport by air benefits in many ways. Just-in-time (JIT) manufacturing system establishment and maintenance became more achievable due to the air transport, as well as downtimes in production decreased significantly (ibid., 6). That is the very reason why air shipping is in priority and decided to be chosen over the other transport methods. Though, because of the advanced and high-level transport service, the prices for it are reasonably high compared to the other modes of transport. In spite of this, a shipper is willing to pay for this way of carriage as long as some financial benefit would be received in a short term from customer for the proactive and fast acquirement of high value goods.

Evidently, the shipping by air has its benefits but still there are some aspects which should be considered. For instance, airlines operate according to airport-to-airport scheme (O'Connell & Williams 2011, 235). This fact makes supply chain more complicated in terms of transportation. Integration of the other modes of carriage into the whole transport chain gives a helping hand to it. If the goods are not staying in the cargo terminal at the airport of arrival to be collected by consignee, cargo will be forwarded to some another mode for further transportation to reach its final destination. Among those companies, offering this kind of advanced service by using multiple methods of carriage, are DHL, FedEx, etc. (ibid., 235—238.)

Air cargo industry is broad and has a huge network which is not shocking - with a lot freight comes a lot of shippers and consignees. Many airlines reserve their cargo space on the particular flights for the defined period of time for their main customers – forwarders. Therefore, so-called “forwarder” companies consolidate goods from various shippers that are supposed to travel the same direction and distribute them among the consignees at the destination airport. According to O’Connell and Williams (2011), Gadola (2009) claims that freight forwarders acquire around 90% of the global air cargo transportation in terms of airlines’ capacities (237.)

Moreover, these companies provide value-added services such as customs clearance, packing, etc. The above-mentioned companies have contacts signed with airlines which enable them to reserve space in aircraft and, what is more, transport freight with the discount rates that are agreed beforehand (Billings, Diener & Yuen 2003, 69—79 in Amaruchkul & Lorchirachoonkul 2011, 30—40). This space which is sold to

the forwarder by the airline is called allotment. The forwarders, in turn, have their own customers which are buying the place from them directly.

The space or capacity for cargo is measured either in available freight, in mail tonne-kilometers (AFTKs or AFMKs) or in cargo payload. AFTKs or AMTKs represent how many kilometers can be travelled by the metric tonne of cargo on a single flight. For instance, one tonne of freight which is transported through 1000 kms generates 1000 AFTKs. The situation is a little bit different in terms of cargo payload. Simply put, this measure shows how many kilograms of cargo may be carried on a particular a/c. (ICAO Glossary 2019, 6.)

Air cargo traffic—actual figures or demand for air cargo—has to meet the designated capacity with a regard to maximization of load factors (LF). Cargo LF is a measure that embodies the percentage of an actual cargo tonnage to an available cargo capacity tonnage. The better actual cargo demand meets the capacity available, the greater LF is. Unfortunately, if actual load factor was only based on cargo tonnage, this load factor would not be any close to full accuracy. In reality, cargo LF is computed in a different way with a consideration of many aspects. For instance, air cargo is usually transported in an air Unit Load Device (ULD) or in a bulk compartment of an a/c. The way of transporting the cargo depends on the type of a/c. Regional aircrafts carry cargo in bulk compartment while narrow- and wide-body, and freighter aircrafts consolidate cargo and load it into ULDs. However, the types of aircrafts are going to be discussed later in the current chapter. What is more crucial to clarify now is that cargo build-up is like a “science” in a certain way, and some of its rules have to be presented. Among those are:

- Cargo is transported in ULDs (air containers or pallets);
- ULDs are placed in forward and aft holds of an a/c, bulk hold is not designated for ULD positions;
- ULD has its own volume (as well as bulk compartment) or allowable carrying weight which is rarely fulfilled on its maximum capacity;
- Express and general cargo cannot be mixed;
- Mail is transported apart from general cargo and cannot be mixed with it;
- Transit cargo cannot be loaded along with point-to-point cargo in the same ULD;
- Some customers want a private ULD for use which is a value-added service.

As for the air cargo traffic, this aspect is represented by freight/mail tonnes carried or freight/mail tonne-kilometers (FTKs or MTKs) performed. The idea behind these

terms is the same as in AFTKs or AMTKs calculation minding the fact that it is actual the air cargo traffic now. (ibid., 6.)

Futhermore, traffic is also measured in revenue (freight) tonne-kilometers (RTKs or RFTKs). This term indicates how many tonnes of freight were carried through the defined distance for commercial remuneration. (Boeing 2018, 82.)

Commercial remuneration in air transport is calculated from chargeable weight (CWT). CWT is a dimensional weight which determines the volume of shipment (Maier 2017, 1—921). Then, CWT is multiplied by cargo yield – an airline charge measured in money equivalent per CWT of the shipment (Boeing 2018, 82).

Global trends in air cargo segment of airline business

Air cargo industry experienced a decent number of ups and downs during the previous years. A global economic crisis and low demands are left in the past. Here and now, air cargo traffic is fully recovered from these severe hits. Industrial production is developing, world trade margins are growing so that air cargo traffic has increased by 10.1% in 2017. To compare, the mean growth average accounts 4.2%. This figure is less than half of the air cargo traffic upsurge in 2017. Furthermore, air freight operators significantly rose their yields and load factors which made it possible to increase revenues while expenses were decreased by better utilization of capacity available. As a result, after such a growth, it is expected that air cargo market will be able to sustain any external fluctuations and risks and continues to follow the progressing path. (ibid., 4.)

According to the 12th World Cargo Symposium 2018 which was held in Dallas, Texas from the 13th of March to the 15th of March, 2018, air cargo represents more than 35% of global trade by value. However, it is mentioned that air transport is carrying less than 1% of global freight by tonnage. Simply put, air cargo pushes global value chains forward. (IATA 2018, 1.)

Furthermore, air cargo transport demand increase is affected by commercial companies that want to maximize their profits. Therefore, the best decision for them is to

utilize scheduled passenger air transport to deliver goods as fast as possible. (Gendreau, Laporte, & Seguin 1996, 3—12 in Nahum, Hadas & Kalish 2019, 354—361.)

International revenue traffic of scheduled services also keeps escalating fast taking into consideration the last years. Starting from 2013, there is always a trend of increase in freight tonnes carried and FTKs performed as well as the growth in MTKs which keeps rising rapidly even since 2010 (see Table 1).

Table 1. World revenue traffic – international scheduled services 2008—2017 (adapted from ICAO 2017)

	Freight tonnes		**FTKs**		**MTKs**	
Year	(millions)	Annual growth (%, Y-o-Y)	(millions)	Annual growth (%, Y-o-Y)	(millions)	Annual growth (%, Y-o-Y)
2008	23.9	-0.9	144 992	-0.8	3 213	6.2
2009	23.3	-2.3	132 231	-8.8	3 195	-0.6
2010	30.1	29.2	161 040	21.8	3 399	6.4
2011	31.0	2.8	161 700	0.4	3 473	2.2
2012	30.5	-1.6	159 433	-1.4	3 604	3.8
2013	31.2	2.2	159 920	0.3	3 921	8.8
2014	32.3	3.6	167 806	4.9	4 307	9.8
2015	32.6	0.8	170 107	1.4	4 606	7.0
2016	33.7	3.5	175 978	3.5	4 899	6.4
2017	37.0	9.8	194 349	10.4	5 489	12.0

European international scheduled services form one fourth of the global FTKs (25.9%) in 2017 which holds the second place after Asia and Pacific region with more than one third of share of global FTKs (39.6%) presented in Table 2.

Table 2. Regional distribution of scheduled traffic 2017 – cargo perspective (adapted from ICAO 2017)

International services	FTKs (millions)	% of world air cargo traffic
Europe	50 412	25.9
Africa	4 097	2.1
Middle East	30 732	15.8
Asia and Pacific	76 913	39.6
North America	27 039	13.9
Latin America and Caribbean	5 157	2.7
Total	194 349	100

The forecasts are positively encouraging. In the next 20 years it is expected that air cargo traffic is going to increase by 4.2% on the average per year (see Figure 1). What is for RTKs, air freight is awaited to be following the progressive trend as well. While airmail will grow at a rate of only 2% per year, air freight will overpass it with 4.3% per year. Generally, RTKs´ in 2017 256 billion will be equal to 584 billion in 2037. (Boeing 2018, 7—8.)

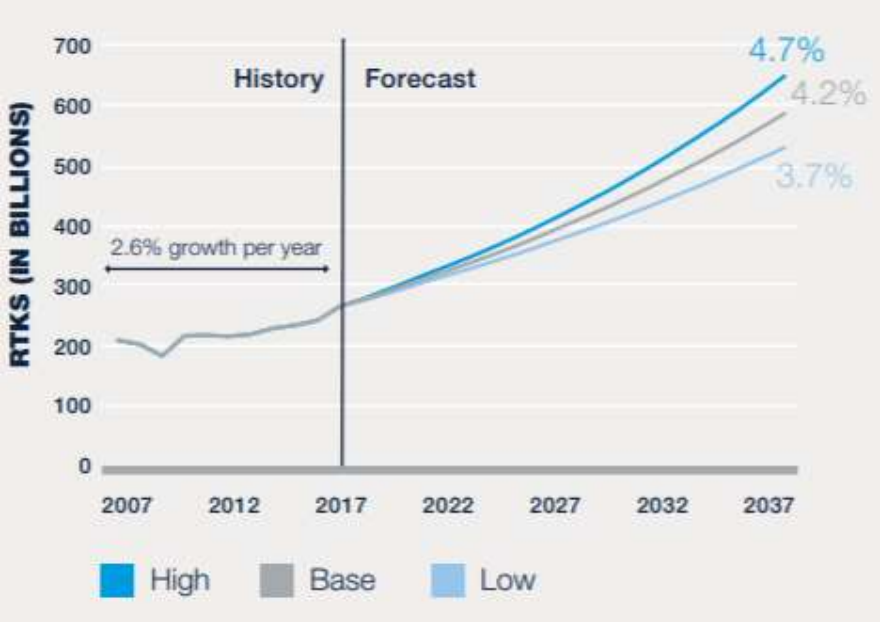

Figure 1. Average annual grow 2018—2037 (Boeing 2018)

[redacted] Passenger business definition

Cargo is not the only concern of the airline industry. Airline industry is primarily driven by the travel demand which means transporting people through the distance by air. People are travelling for various matters and reasons: travel on working purposes, flying to vacations, or visiting family members or friends.

The traffic for passenger airlines is usually measured by the number of air passengers (pax) transported or in revenue passenger-kilometers (RPKs). The last one means the actual number of passengers who travel over specific distance in kilometers on a particular flight with the remuneration to an operating airline. As an example, if one passenger travels 1000 kilometers, he or she will generate 1000 RPKs. (ICAO Glossary 2019, 8.)

Regarding the fares applied to the passenger transport, they usually depend on different factors: seasonality, destination demand, distance of O-D route, and, of course, the characteristics of fare (e.g. economy, business or first classes) (Belobaba et al. 2015, 397r). People may choose to travel during public holidays in their home country or to a big event happening on their destination. Besides, there is usually an increased demand in warm countries during summer as people have their holidays started. Typically, fares are higher due to these matters. In addition, the distance to be flown influences on the ticket fares as well. The farther is the destination, the bigger the fare for the flight is. Additionally, people decide how comfortable they would like to have their journey and choose from the options of carriage suggested by the carrier. If they like to travel with more privileges, they will likely select more expensive fare. That is why there are the classes of carriage (e.g. economy, business and first class).

Air passenger traffic matters were discussed previously in this chapter, except for the capacity. Mainly, the passenger flight capacity is shown in number of seats or available seat-kilometers (ASKs). The calculation of this one is simple and similar to the other like AFTKs of AMTKs – multiplication of seat number by the distance to be travelled. Moreover, load factor (LF) is also applicable to passenger transportation and calculated and expressed the same way as for cargo LF. (ICAO Glossary 2019, 8.)

Global trends in passenger segment of air transport business

Aviation's focus is aimed on the customer. Travelers want their journey to be as smooth, less time-consuming, transparent, comprehensible and efficient as possible through the whole process of it. Infrastructure is developing, the level of service is rising so the standards for transportation are emerging, due to the upsurge trend in

passenger numbers during the last years. Beginning from 2008, the tendency of increase is still in place. Every year, the number of transported passengers grows by 6.51% on the average (see Table 3). Clearly, the number of RPKs performed keeps progressing as well. Larger quantity of passengers and new destination openings lead to longer distances travelled.

Table 3. World revenue traffic — international scheduled services 2008-2017 (adapted from ICAO 2017)

	Number of pax		RPKs	
Year	(millions)	Annual growth (%, Y-o-Y)	(millions)	Annual growth (%, Y-o-Y)
2008	920	3.9	2 820 625	3.1
2009	932	1.3	2 784 646	-1.3
2010	1 031	10.6	3 021 487	8.5
2011	1 119	8.5	3 251 718	7.6
2012	1 186	6.0	3 451 146	6.1
2013	1 247	5.2	3 648 046	5.7
2014	1 327	6.4	3 874 721	6.2
2015	1 430	7.7	4 163 446	7.5
2016	1 539	7.6	4 483 059	7.7
2017	1 660	7.9	4 860 927	8.4
Average		6.5		6.0

Regarding Europe and international scheduled services, it obviously overperforms any other region of operation. Almost a half of the whole world's passenger number carried (47.6%) is represented by Europe. Analogous situation can be observed in the passenger kilometers figures — 36.7% is a share of Europe in the world of aviation business. The passenger load factors (84%) are noticeably higher compared to the other world's regions. (See Table 4.)

Table 4. Regional distribution of scheduled traffic 2017 – passenger perspective (adapted from ICAO 2017)

International services	Passengers numbers (thousands)	RPKs (millions)	Passenger LF
Europe **% of world traffic**	790 652 47.6%	1 782 198 36.7%	84%
Africa **% of world traffic**	50 630 3.0%	137 806 2.8%	70%
Middle East **% of world traffic**	178 709 10.8%	694 470 14.3%	74%
Asia and Pacific **% of world traffic**	423 001 25.5%	1 429 884 29.4%	80%
North America **% of world traffic**	148 252 8.9%	610 714 12.6%	82%
Lain America and Caribbean **% of world traffic**	69 241 4.2%	205 856 4.2%	82%

Positive trend in passenger traffic is expected in 2019 – RPK's growth of 6% globally in 2019: 8% in Asia/Pacific region, 6% in Europe, Latin America and the Middle East, 5% in Africa and North America. Continuous demand increase may encourage airlines to keep expanding their capacities. However, it is obvious for experts that capacity growth should be slowed down. Subsequently, European capacity expansion is not expected during summer schedule to be as huge as during the winter ones. (Lufthansa Group 2018, 80.)

Thereby, the growth is clearly pointed out which keeps following the progressive path, most of revenues is coming from passenger transportation. Evidently, passenger side of aviation business compose a crucial, valuable and immense part of it. That is why this segment is going to be discussed along with the cargo one in the current study.

All-cargo vs combination carriers

People can be transported only with passenger airlines. This chapter is going to deliberate and illustrate two airline business models, one of which specializes on passenger transportation along with cargo.

In terms of airline operations, cargo transportation is either main or side business. Thus, there are two main types of airlines which are conducting its revenue made from cargo transport: all-cargo operators or freighter airlines and full-service carriers (FSCs) or combination carriers. These are reflected as commercial air transport operators which make revenues for scheduled or non-scheduled transport service for cargo and passengers (ICAO Glossary 2019, 4).
There is no need to describe in a full manner an every single airline type as only two of them are going to be considered during the study, and only one is going to be addressed. Those are the airlines which stick to the full-service network and all-cargo business models. Nevertheless, fundamental clarification is still required in order to familiarize the reader of this thesis with the basics.

While all-cargo carrier is making profit from moving various commodities of cargo using freighters (cargo aircrafts), combination or FSC moves the same cargo in the commercial aircrafts along with the passengers. The upper deck of those aircrafts is dedicated for passenger seating while the lower deck is used for passengers´ baggage and cargo. Cargo can be moved on the passenger aircraft only if there is capacity left for it. Passenger belongings are always a priority for loading. Therefore, the ULD positions which are not occupied by passenger baggage are given for cargo transport for further utilization. (See Table 5, Service & Pricing and Revenues.)

Every airline focuses on a direct market: domestic or international. When airline specializes in domestic operations, it means that the airline’s market is centered on its home country. On the contrary, the international market is shared by airlines which operate outside the borders of their homeland. Afterwards, the market creates competition so that FSCs may oppose other combination carriers regarding passenger and cargo transport while all-cargo carriers are trying to fight over their competitors in the same service provided. Additionally, FSCs and all-cargo operators are playing at

the same field – cargo market. As it has been already mentioned, FSC can also transport cargo of different conditions and dimensions. Surely, the freighter's service is more advanced than FSC's. (See Table 5, Market.)

Moreover, these carriers can operate different kinds of aircrafts starting from regional jets and ending even with freighter planes. They are flying according to hub-and-spoke (H&S) model meaning that global coverage can be achieved easily. H&S model represents a system which offers air transportation to the main airport from where more destinations are available (O'Connell & Williams 2011, xxxvii). According to Nahum, Hadas and Kalish (2019, 354—361), Moreno-Izquierdo, Ramon-Rodriguez and Ribes (2015, 651—660) state that H&S network made it possible to optimize cargo transportation while using the most optimal routes. Hub airport primarily serves as a transit airport from where people or goods will fly to their next point of journey or straight to the destination. Therefore, H&S model has a wide range of origins and destinations with the less routes and, consequently, less amount of operating aircrafts. (Cook & Goodwin 2008, 51—60.) (See Table 5, Operational model.)

Considering the fleet operated, each of these two airline business models has their own a/c type preferred. While all-cargo carriers are using freighter aircrafts, FSCs are taking advantage of passenger aircrafts (regional, NB and WB) as well as from freighters but in smaller quantities. (See Table 5, Fleet.)

Table 5 shows the aggregated information presented above in terms of two airline business models: combination and all-cargo carries.

Table 5. Distinction between All-cargo carrier and Full-service carrier (adapted from Deutsches Zentrum für Luft- und Raumfahrt e.V. 2008)

	FSCs / combination carriers	**Freighter/All-cargo carriers**
Service	• Passenger and cargo transport (passenger transportation is a priority) • Cargo carriage is a side-business	• Cargo transport

Market	• Domestic and international • Competition with other FSCs in terms of passenger transport and all-cargo carriers in terms of cargo transport; • Trying to achieve better level of service compared to other FSCs; • Air cargo is a side business – priority is given for passenger baggage, then the left space is given for cargo; • Cargo restrictions concerning carried commodity of freight (as an example, radioactive substances or dangerous goods);	• Domestic but mainly international because of international trade flows • Competition with FSCs and all-cargo carriers in terms of cargo transport; • More capacity for oversized cargo; • Enhanced service for special commodity cargo;
Operational model	• Hub-and-spoke network • Wide range of origins and destinations • Scheduled and frequent service • Tight connection with freight forwarders	• Scheduled or charter flights • Sometimes integrators • Works with freight forwarders
Pricing and revenues	• Complex yield management • Price discrimination • Most of profit from passenger side of business • Ad-hoc rates and space allocations	• Ad-hoc rates and space allocations • Profit only from cargo carriage
Fleet	• Regional jets • Narrow-body aircrafts (NB a/c) in majority • Wide-body aircrafts (WB a/c) in minority – used usually between hubs where traffic volumes are high • Freighter a/c (small quantity)	• Freighter aircrafts

According to CAPA (2019, Data Center: Performance) airlines ranking list, cargo specialized carriers account 43 companies versus FSCs' number of 216 companies which is five times greater. Additionally, when the same statistics is addressed, combination carriers are the ones which own most of the market in cargo payload by kilograms. Figure 2 shows that the first ten airlines presented position themselves as FSCs and carry the most of cargo in kilograms.

Rank	Airline	IATA	ICAO	Total	Percentage Market Share
1	American Airlines	AA	AAL	99,157,165	4.0%
2	Emirates Airline	EK	UAE	92,746,294	3.7%
3	Delta Air Lines	DL	DAL	84,332,070	3.4%
4	Qatar Airways	QR	QTR	78,222,621	3.2%
5	China Southern Airlines	CZ	CSN	75,616,330	3.0%
6	Cathay Pacific	CX	CPA	74,841,797	3.0%
7	United Airlines	UA	UAL	69,213,484	2.8%
8	Korean Air	KE	KAL	66,699,419	2.7%
9	Lufthansa	LH	DLH	61,907,881	2.5%
10	Turkish Airlines	TK	THY	60,913,130	2.5%

Figure 2. Market share among airlines, cargo payload in kg (CAPA 2019)

Combination carriers can also operate freighter aircrafts as all-cargo carriers do. The key point is that higher capacity utilization can be achieved by FSCs which use freighters in their operations (O'Connell & Williams 2011, 244—246). That might be also the reason why first ten leading positions are occupied by passenger airlines.

AFTK's index (CAPA 2019, Data Center: Performance) has to be also analyzed and taken into consideration as it shows the available amount of cargo transported over kilometers. As it can be observed from Figure 3, again FSCs are leading here in terms of air freight.

Rank	Airline	IATA	ICAO	Total	Percentage Market Share
1	Emirates Airline	EK	UAE	426,560,356	5.7%
2	Qatar Airways	QR	QTR	385,950,318	5.2%
3	Cathay Pacific	CX	CPA	342,533,879	4.6%
4	Lufthansa	LH	DLH	272,097,654	3.7%
5	United Airlines	UA	UAL	261,093,819	3.5%
6	Korean Air	KE	KAL	251,531,345	3.4%
7	American Airlines	AA	AAL	242,480,052	3.3%
8	Delta Air Lines	DL	DAL	230,426,035	3.1%
9	China Southern Airlines	CZ	CSN	225,132,674	3.0%
10	Singapore Airlines	SQ	SIA	212,251,850	2.8%

Figure 3. Market share among airlines, AFTKs (CAPA 2019)

ASK's statistics (CAPA 2019, Data Center: Performance) is represented in Figure 4. It shows the list of ten leading full-service carriers in the market. Those airlines compose almost one third of all market share by seat capacity in kilometers.

Rank	Airline	IATA	ICAO	Total	Percentage Market Share
1	American Airlines	AA	AAL	8,791,247,814	4.6%
2	United Airlines	UA	UAL	8,650,396,963	4.5%
3	Delta Air Lines	DL	DAL	8,315,103,048	4.3%
4	Emirates Airline	EK	UAE	7,459,978,798	3.9%
5	Southwest Airlines	WN	SWA	5,180,855,765	2.7%
6	Qatar Airways	QR	QTR	4,432,200,011	2.3%
7	China Southern Airlines	CZ	CSN	4,177,291,418	2.2%
8	China Eastern Airlines	MU	CES	3,668,117,641	1.9%
9	Air China	CA	CCA	3,619,496,609	1.9%
10	Lufthansa	LH	DLH	3,580,476,474	1.9%

Figure 4. Market share among airlines, ASKs (CAPA 2019)

In fact, those FSCs earn their profit mainly from the passenger travels, not from cargo movements. For comparison, in 2017, revenues for passenger carriage by commercial airlines was equal to $534 billion whilst for cargo this figure was much less - $95.9 billion. Hence, the majority of 84.8% of revenues comes from passenger side of business. However, 15.2% is not insignificant, and its value cannot be undermined at any matter. Oppositely, exactly this percent of revenue can help an airline to make a

difference in its financial performance meaning escaping from losses and gaining more profits from flight operations. (IATA 2018, 1—2.)

The airline planning process: fleet planning and assignment

Planning process for an airline is a long-term procedure followed by strategic solutions and decisions to be made and executed. All the steps and actions should be considered while the planning process is going on. Otherwise, outcomes can be expressed in the increased expenses, as an a/c acquirement requests for a huge investment, or sometimes even decrease in revenues. Meaning that, for example, transit time at a certain airport is so long-lasting so that the passenger will not choose this travel route to be worth followed. Then, the yield for the current destination will drop and revenues will go down. However, this chapter is not planned to be about financial performance of an airline. An airline planning process and its main parts will be discussed.

Airline fleet planning process

An airline planning process starts from the fleet planning. To clarify, what is the type of an a/c to be used, when it is going to be used, and how much of these. Fleet of the airline is usually described by the number and the types of aircrafts which are operated by this airline in a specific time or period. Every single type of the a/c differ from one another by several means of technical specifications like capacity measures, flying distance, etc. (Belobaba et al. 2015, 597t). Economically, some of the aircrafts can operate for a couple decades and still make profit for the airline. Surely, their technical condition is precisely monitored and maintained.

Nevertheless, the factors that influence an airline's a/c type decisions shall be deliberated next. Every single aspect should be thought out as the airline fleet planning decisions impact drastically in economic and financial ways. Size and range of an a/c are the ones of major characteristics which are considered in the first place when making a final decision. In fact, the largest planes (wide-body aircrafts) are produced and supposed to fly long-haul destinations (ibid., 597v). However, with the growth of demand on some long-haul flights, even the biggest a/c in the airline's fleet can be operated.

There are four types of aircrafts which are operated by FSCs: regional jets, narrow- (NB) and wide-body (WB) aircrafts, and freighters. Most of the FSC´s fleet is represented by NB fleet while regional jets, WB aircrafts and freighters are in minority. (CAPA 2019, Data Center: Fleet.)

Nowadays, short- and medium-haul distances are usually served by regional jets (e.g. CRJ-200, around 70 seats) or NB aircrafts (e.g. B737-700, A319, A320 around 125—150 seats). The reason for using those types of planes is to cope up with relatively low demand or to increase frequency on short-haul routes while keeping the airline's operating costs low. (Belobaba et al. 2015, 597u—597w).

As well as cars have different manufacturers or producers, aircrafts have those too. Pursuant to Aviation Daily (2016, 7), Boeing and Airbus are competing in the market of commercial aircraft production with 38% and 28% respectively. Moreover, it is expected that these two aircraft manufacturers will share the market almost equally by 2025 with the steady growth of Airbus. Besides, from the recent statistics of CAPA (2018), it can be clearly seen that Airbus is already catching up with Boeing. Almost one third of the whole global fleet in today's service has been manufactured by Airbus while the number of Boeing planes in service is a little ahead (see Figure 5). To survive in this rival market and match customer's and airline's requirements, the aircraft manufacturers are trying to construct new aircraft models with different and even enhanced configurations to be able to offer those to airlines.

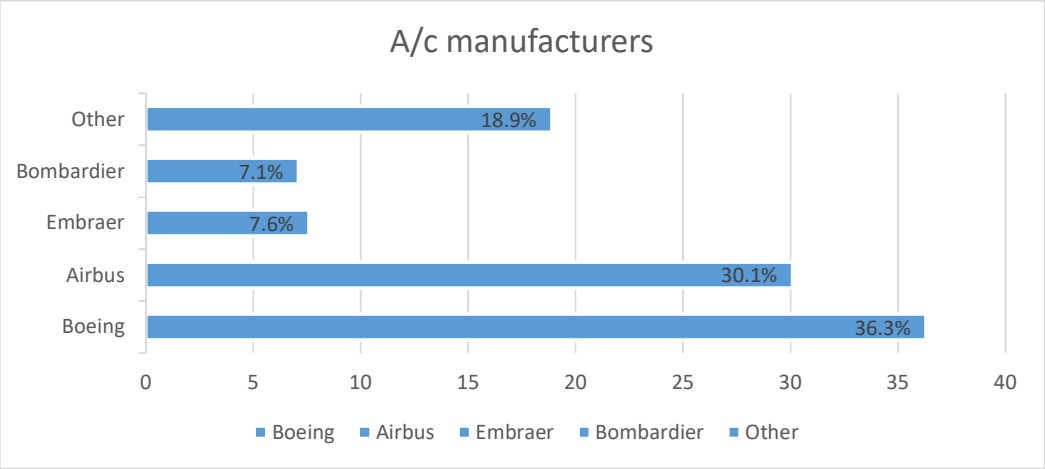

Figure 5. Original aircraft manufacturer market share (adapted from CAPA 2019, Data Center: Fleet)

Not only aircraft's range and size play important role in the final decision of fleet combination but also other technical and performance specifications. Airport facilities which will be used in airline's operations should be taken into account as well. Each a/c type has different takeoff and landing weights which have the direct influence, for instance, on the length of airport runway. Additionally, the choice upon the a/c type can comprise constraints for ground operations. Each a/c type requires exclusive ground equipment to be serviced with. (Belobaba et al. 2015, 597w—597y.)

It is no wonder that traffic and demand figures effect significantly on the fleet planning process. In this way, the most important steps should be taken:

1. An accurate forecast of expected passenger and cargo traffic should be conducted. The traffic (as mentioned above) can be expressed in RPKs/RTKs/cargo payload/number of passengers regarding the route an a/c will be following (origin to destination airport);
2. After the analysis was made, the outcomes of it can be used in determining of the "target average load factor" which should be achieved. Thus, ASKs/number of passengers and AFTKs/cargo payload are decided to cope with the forecasted demand figures considering the load factor to be realized still;
3. When the assumed number of passengers and cargo payload are provided, the a/c type assignment or change can be performed;
4. Moreover, it is worth remembering that every change incurs financial impacts expressed in operating costs. So that the estimated cost calculations are needed;

5. Changing or acquiring new a/c at a route is not only about costs to be handled. It is expected that the profit from this kind of decision will be reasonable or greater than it was before the change. Therefore, the revenues calculation gained from the a/c operations is to be made taking into consideration traffic forecasts and yield that expected to be generated. (Belobaba et al. 2015, 598a-598c.)

Above steps make airline to decide and justify upon the choice of the specific type of an a/c flying a particular route with a defined frequency. The more detailed airline fleet planning process can be found below (see Figure 6).

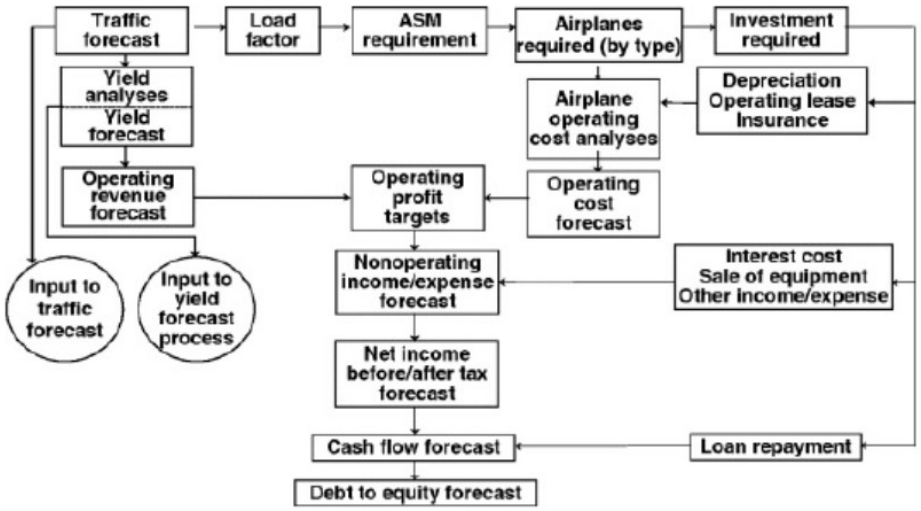

Figure 6. Airline fleet planning process (Belobaba et al. 2015)

Fleet assignment process

"Fleet assignment" term sometimes can be mixed up with the term "fleet planning" which was used in the previous subchapter. The difference between those two is that fleet planning intends to analyze and decide upon the a/c type which is the most suitable and profitable on destination, and fleet assignment covers the tactical deci-

sion upon the existing fleet by analyzing present options – aircrafts in stock or already in service. In other words, fleet assignment's aim is to find profit and capacity utilization maximizing configuration of an a/c operated on a route.

In order to avoid unnecessary operating costs and loss in revenues, wise assignment of operating fleet should be performed. Loss of revenues can be explained by the restricted capacity of an operated a/c. If the capacity is fully used, and there are overbookings on the flight to be performed with the specific a/c, the potential revenues will be lost. This situation can be solved by assigning the bigger a/c on the particular destination. Unnecessary costs are expressed in expenses spent on the service of an a/c. Thus, there are several points which have to be considered while making a decision:

- Traffic forecast;
- Availability of existing aircrafts in airline´s fleet;
- Minimum ground times;
- Maintenance requirements.

There is a need to come up with the "optimal" a/c type in the end by reflecting the whole rotation of an a/c assigned. The rotation means the route which is flown to and back from the destination airport. (ibid., 596y—596z.)

Flight frequency planning process and scheduling

Along with the fleet assignment process goes flight frequency planning and scheduling, in essence of number of flights per defined period of operations. Well-organized schedule can result in many advantages like traffic increase as well as revenue growth. Peak departure times are falling to be in the mornings and evenings, around 8—9 a.m. and 5—6 p.m. respectively. Besides, the competition in congested airports may be aggressive. For this very reason it is rationally to have bigger share in frequencies of operations, especially for short-haul flights. H&S network influences a lot when the decision upon the operation frequency comes to hand. Hub's connecting flights can generate even greater traffic on the route. Sometimes, if route account a weighty share of connecting passengers, the frequency to the hub can be increased along with the decrease of costs per seat-kilometer (SK). (ibid., 598u.)

[redacted]Airline operating performance

Every business needs to make profit to survive in a harsh market and its internal competition. The profit is what left after all the costs have been subtracted from the gained revenues.

Unit cost represent the financial statement for expenses which can be calculated by diving operating expenses by TKs performed or by ATKs (if the expenses are estimated or forecasted). On the other side, operating yield represent financial statement for airline revenues which can be computed by diving operating revenues by TKs or ATKs. (ICAO Glossary 2019, 8.)

Operating revenue of an airline depends on several drivers. At the same time, these drivers influence each other either which makes them interdependent (Stalnaker, Usman, Taylor & Alport 2018, 14). For instance, the passenger or capacity enlargement can be followed up with the reduction in passenger or cargo yield respectively afterwards. Subsequently, low yields will influence on the revenue values.

Each particular driver has its own impact on operating revenue of an airline in the sense that the effect of each separate driver is different. When these drivers are well-managed, guided and analyzed, the carrier's revenue figures can be increased with the help of deliberated strategic solutions for their realization. According to Stalnaker et al. (2018, 14), there is a list of the most crucial drivers for airline's operating revenues (see Figure 7): capacity, passenger yield, load factor, fees/other and cargo. Regarding international network carriers, their impact ranking is shown below:

- #1: Capacity;
- #2: Load factor;
- #3: Cargo;
- #4: Passenger Yield;
- #5: Fees/Other.

To clarify, if the capacity offered has been decided to be enlarged and there is no demand in its utilization, then the load factors will drop. Unused capacity will be either sold out with the lower prices, to compensate the losses of extra capacity, or increasing the prices, to do the same, but to the detriment of demand. From this moment, yield is only dependent on wise and thought-through management of an airline.

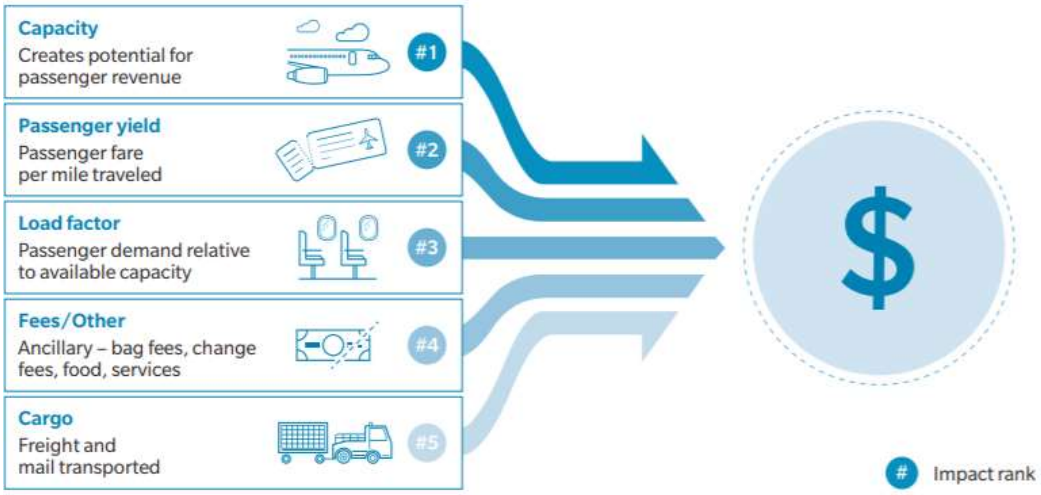

Figure 7. Main drivers for airline's operating revenues (Stalnaker et al. 2018)

All the drivers above (see Figure 7) depend on the demand which is coming from (in our case of FSC business model) cargo and passengers. Obviously, without demand there is no sense in conducting any type of business. For instance, if there is low air cargo or passenger demand, the load factors will drop, capacity utilization will be low, yields will decrease and, consequently, the profit expected will be reduced.

With increased competition in the aviation market, control of operating costs became more vital for the financial performance of airlines. Operating expenses or costs consist of direct operating costs (DOC) and indirect operating costs (IOC) which composites are as following and presented in Table 6.

Table 6. Operating costs breakdown (adapted from ICAO 2019)

DOC	IOC
Flight operations	Station expenses

Flight equipment maintenance and overhaul	Passenger services
Flight equipment depreciation	Ticketing, sales and promotion
User charges (airport and en-route air navigation charges)	General and administrative

Moreover, as there are some crucial drivers for revenues, there are the different drivers for expenses. The most three important ones form around 40% of airline's costs in a whole. These costs and their breakdown are presented in the Table 7.

Table 7. Main drivers for airline's costs (adapted from IATA 2017)

Driver	**Percentage**
Aircraft fuel and oil	~22%
Flight equipment maintenance	~10%
Passenger services	~9%

Fuel costs have always been volatile, and this fact is not surprising due to the fluctuations in world's oil price. Flight equipment maintenance includes overhaul, inspection and repair tasks connected to a/c maintenance. Passenger services costs represent all the expenses on the activities performed (handling of passengers) by the airline to satisfy the passenger with the prescribed level of service. (IATA 2017, 1.)

The most recent study by ICAO (2017) showed that there was a slight decrease in operating result or net profit of $5,500 million in 2017 comparing to the previous year — 2016. The reason behind this was that the difference in operating expenses was greater than the difference in operating revenues between these two years had been analyzed. (11.)

First of all, what influenced the reduction in operating revenues is that decrease in yield ($0.801 in 2017 and $0.814 in 2016) of $11,831 million was observed. However, at the same time it was compensated by the upsurge in traffic (RTKs of 945,365 million in 2017 and 871,117 million in 2016) which accounted $60,431 million. Unfortunately, as it has been already mentioned, the difference in operating expenses that year were a little higher than difference in revenues. Unit cost ($0.504 in 2017 and $0.494 in 2016) and capacity offered (TKs of 1,384,492 million and 1,303,304 million in 2016) increase of $54,100 in sum contributed to the final operating result of $5,500 million decrease. (ibid., 11.)

3.3 Background research: Lufthansa/Lufthansa Cargo

Lufthansa (LH) is a commercial airline that operates under FSC model which specifications can be addressed in Table 5. Airline has its headquarters in Cologne and the main hubs in Frankfurt (FRA) and Munich (MUC) airports. LH's network is broad which covers several regions: primarily within Europe with its domestic and international flights but also in the North and South America, Asia, the Middle East and Africa.

LH, as a FSC, operates regional jets, narrow- and wide-body aircrafts which are able to carry passengers and cargo on the same board. Thus, air cargo business of LH is going to be analyzed firstly in general, then regionally, and later on regarding station in Saint Petersburg (LED) in terms of demand fluctuations and their trends of change. Next, the same analysis is going to be provided concerning passenger side of the current airline's business.

[redacted]LCAG: air cargo business – traffic and capacity overview

In order to be able to continue with the main study of this thesis work regarding fleet utilization and assignment, demand analysis for Lufthansa has to be presented.

Lufthansa Cargo (LCAG) is a subsidiary company and represents a logistics business segment of LH airline which arranges transportation for air freight and mail. Freight can be special commodity (live animals, dangerous goods, vulnerable ore valuable cargo, and etc.) or express, and LCAG suggests its transport service still. Besides that,

temperature-sensitive goods are appropriately served as well. For this exact commodity, for instance, Lufthansa Cargo Cool Centre is present and functioning in FRA. Moreover, LCAG is the leading freight airline in Europe. LCAG does not want to stop at this point and wants to expand. Thus, LCAG tries to build up a strong cooperative partnerships as well as minimizing its own costs. (Lufthansa Group 2018, 56.)

Due to annual growth of air cargo volumes (see Table 1) and expected increase of RTKs globally (see Figure 1), air cargo traffic and capacity figures for LH are supposed to be rising as well.

Starting globally, accumulated statistics of the air cargo capacity by LH shows volatile pattern during the period of five years (see Table 8, cargo payload and AFTKs). For example, there was a considerable growth, expressed in cargo payload in kilograms, of 17.5% in 2014 compared to 2013 while the next year — 2015 — the capacity was restrained by 4.7%. Fortunately, cargo payload capacity is finally restored in 2018 with 3,340 million kg repeating its peak in 2014 with 3,399 million kg. What is for the AFTKs, the figures are unstable during the same period of five years. However, starting from 2017, the rise of AFTKs can be perceived. With these numbers, LH positions itself the 9th out of 775 in cargo payload and 4th out of 775 in AFTKs in the global market. What is for cargo LF, it kept growing till its drop in 2018 by 3.2% (see Table 8, cargo LF). The reason behind that eventual decrease was that the enhanced belly capacities could not be fulfilled because of the lower relevance of cargo transportation on these operated routes. To the contrary, LH's air cargo traffic is positively encouraging. RFTK figures are slowly rising annually after their drop in 2014—2015 (see Table 8, RFTKs).

Table 8. LH annual global capacity and traffic trends (adapted from CAPA 2019 and Lufthansa Group Annual Reports (Logistics) 2014—2018)

Year	Cargo payload (kg) in millions	Cargo payload growth (%, Y-o-Y)	AFTKs in millions	AFTKs growth (%, Y-o-Y)	RFTKs in millions	RFTKs growth (%, Y-o-Y)	Cargo LF (%)
2014	3,399	17.5	12,354	-1.1	8,612	-1.4	69.7

2015	3,241	-4.7	12,606	2.0	8,364	-2.9	66.3
2016	3,123	-3.6	12,553	-0.4	8,385	0.3	66.8
2017	3,044	-2.5	12,867	2.5	8,886	6.0	69.1
2018	3,340	9.7	13,555	5.0	8,934	1.0	65.9

With the growth of air cargo traffic in world market (see Table 5), LH tries to expand its own capacity in order to have a chance to penetrate some part of this global growing trend.

International traffic of air cargo is overcoming domestic traffic. For this reason, share of international cargo payload was equal to 85.6% whilst domestic accounted 14.4% in 2018. AFTKs internationally are substantially higher than domestically - 98.3% and 1.7%, which is obvious due to the longer distances travelled internationally than domestically. (CAPA 2019.)

There is a need to cut the area to be analyzed step by step. The whole Europe shares 25.9% of all global air cargo (see Table 2). Therefore, looking into the respective figures distributed by regions, Eastern/Central Europe with its 3.2 million kgs available for transportation gives the way to North America, North East Asia and Western Europe with more than 5 million each (see Figure 8).

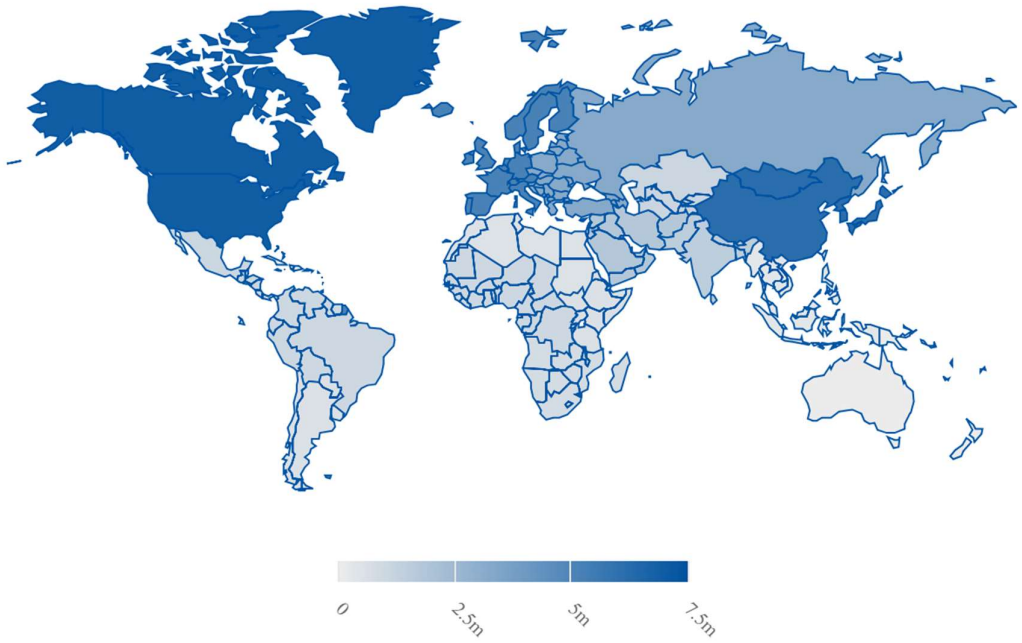

Figure 8. Lufthansa international departing cargo payload (kg) by region (CAPA 2019, Data Center: Performance)

With the respect to AFTKs, Eastern/Central Europe is far away with its almost 7.5 million from North America and North East Asia accounting more than 87 million in total (see Figure 9). This huge difference is understandable because of the greater distances flown from/to America and Asia than inside Europe.

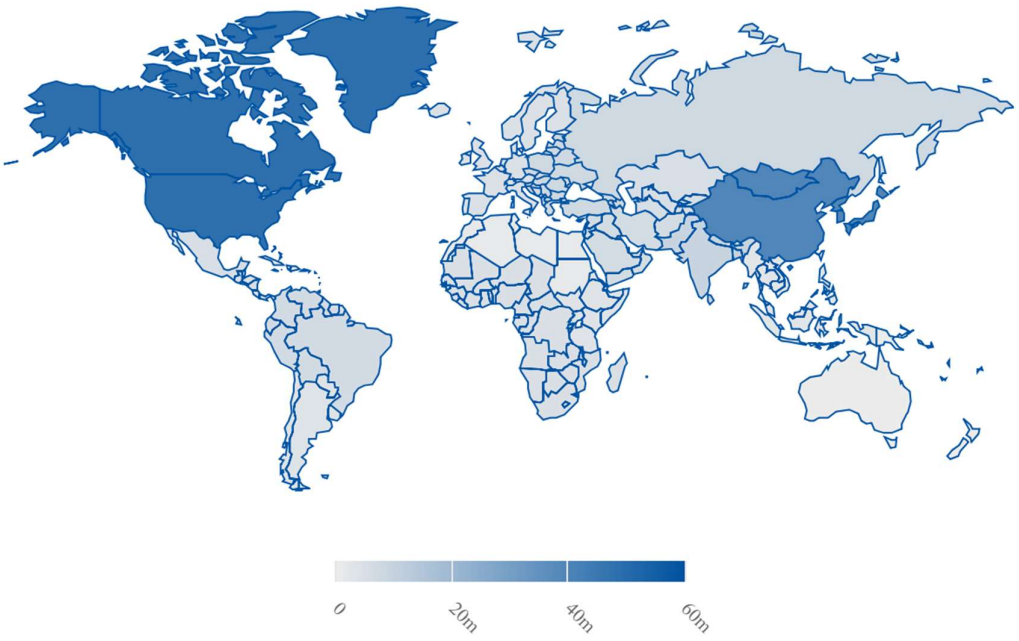

Figure 9. Lufthansa international departing AFTKs by region (CAPA 2019, Data Center: Performance)

Restraining the boundaries for analysis in a greater scale, LH's international cargo payload in Russian Federation totals 359,414 kg. This figure is noticeably small comparing to, for instance, 7,098,518 kg in the US. (CAPA 2019.)

[redacted]LH: air passenger business – traffic and capacity overview

LH's air cargo business was discussed in previous chapter. This chapter is going to elaborate LH's passenger side of business.

As LH is a passenger airline, so its main business is obviously focused on the passenger transportation. The airline has a broad network which connects every single continent. Around 80% accounts transit passengers and only 20% are travelling point-to-point (Internal source: statistics and observational study). Transit passengers are

those who have one or more than one connection before reaching the final destination. Therefore, it is very critical that passengers meet their connections, or, either way, the potential revenue is going to be lost. However, this point will be discussed later in the same chapter. For now, the main idea is to see whether there are any trends in terms of traffic and capacity for LH in general.

More and more people are travelling by air, and the justification is in the rising numbers of passengers and ASKs figures worldwide (see Table 3). When addressing the number of passengers (see Table 9), it can be noticed that Lufthansa was doing satisfactory before its fall in 2016. Apparently, this happened because of capacity restrictions in the same year when it was restrained by 8.7%.

Table 9. Lufthansa's passenger numbers and ASKs - globally (adapted from CAPA 2019, Data Center: Performance)

	Number of pax (thousands)	**Number of pax growth (%, Y-o-Y)**	**ASKs (millions)**	**ASKs growth (%, Y-o-Y)**	**LF, %**
2014	77,547	1.7	197	1.5	79.4
2015	79,305	2.3	202	2.5	80.2
2016	62,418	-21.3	184	-8.7	79.1
2017	66,234	6.1	187	1.8	81.6
2018	70,108	5.8	196	4.8	81.4

LH claims that the numbers declined because of political and economic situation in South America and Asia. Moreover, due to overcapacity, operating costs increased (Lufthansa Group 2016, 42). The positive fact is that the passenger traffic is restoring step-by-step as well as the capacity does. It is expected that the figures will be the same in 2019 as they were in 2014. Surely, the airline aims higher. However, there is more logic in achieving the goal by making small but confident steps rather rushing as fast as they can to reach it.

Table 10. Lufthansa's passenger numbers and ASKs - Europe (adapted from CAPA 2019 and Lufthansa Group Annual Reports 2014-2018)

	Number of pax (thousands)	Number of pax growth (%, Y-o-Y)	ASKs (millions)	ASKs growth (%, Y-o-Y)	LF, %
2014	62,210	1.8	66,185	0.4	75.1
2015	63,350	1.8	66,198	0.0	76.3
2016	64,749	2.2	69,196	4.5	74.8
2017	51,781	-20.0	49,730	-28.1	76.0
2018	57,314	10.7	59,288	19.2	76.5

In 2017, European capacity in ASKs was restricted significantly by 28.1% in a way that number of passengers dropped, as a result, by 20%. Fortunately, this severe loss was partly restored in the upcoming year. With this performance, LH is positioned 9th out of 775 both in number of seats and ASKs globally. Furthermore, worldwide load factor (LF) for Europe is 84% (see Table 4) while LH's load factors are around 10% lower than the European average. (See Table 10.)

[redacted]LH/LCAG: existing fleet and schedule planning

In order to propose the most optimal solution of the a/c assignment, an overview of the whole LH fleet has to be presented. Table 11 below summarizes all a/c types with the models and their specifications (e.g. seat and cargo capacities). The table also includes ULD configuration for each a/c model presented.

Table 11. LH fleet composition (adapted from Lufthansa Group 2019 website and calculated from Lufthansa Group 2019 Aircraft Type Manual)

Type A/C	A/c MODEL	In service	In storage	On order (confirmed)	Number of seats	Cargo payload (kg)	ULD configuration
Regional	Bombardier CR900	35	0	0	90	920	BLK
Regional	Embraer190	9	0	0	100	1600	BLK

Regional	Embraer 195	17	0	0	120	1550	BLK
Total regional		**61**	**0**	**0**	**0**		
NB	Airbus A319-100	30	0	0	138	4100	BLK
NB	Airbus A320-200	73	0	6	168	2600	7 ULDs (AKH/PKC)
NB	Airbus A320-200neo	18	0	67	180	2600	7 ULDs (AKH/PKC)
NB	Airbus A321-100	20	0	0	200	5000	10 ULDs (AKH/PKC)
NB	Airbus A321-200	43	0	0	200	5000	10 ULDs (AKH/PKC)
Total NB		**210**	**0**	**73**			
WB	Airbus A330-300	17	0	0	216	31000	12 AKE, 6 PMC, BLK
WB	Airbus A340-300	15	0	0	279	28000	12 AKE, 6 PMC, BLK
WB	Airbus A340-600	10	1	0	297	24400	12 AKE, 7 PMC, BLK
WB	Airbus A340-600(HGW)	7	5	0	297	24400	12 AKE, 7 PMC, BLK
WB	Airbus A350-900XWB	13	0	13	293	28200	20 AKE, 4 PMC, BLK
WB	Airbus A380-800	14	0	0	509	9200	16 AKE, 6 PMC, BLK
WB	Boeing 747-400	13	0	0	371	23000	12 AKE, 6 PMC, BLK
WB	Boeing 747-8	19	0	0	364	45000	18 AKE, 7 PMC, BLK
Total WB		**108**	**6**	**13**			
TOTAL		**354**	**6**	**86**			

Total number of aircrafts (354) is computed by summing up all the regional, NB and WB a/c models. The greater part of entire LH fleet composes NB a/c type (210). What is to mention more is that 354 aircrafts are in service right now while six aircrafts are in storage and 86 are on confirmed order. The aircrafts that placed on order are expected to be delivered and start operating during the next ten years. (See Table 11.)

Depending on the type and model of an a/c, passenger and air cargo capacities vary. Number of seats are established for each a/c model as well as air cargo capacity in

kilograms. Some of the models can carry cargo in bulk or ULDs. Cargo payload is calculated considering the full passenger and fuel load and excluding passenger baggage. Passenger baggage weights approximately fifteen kilograms per bag and occupies full ULD with 30 bags in NB a/c and 45 bags in WB a/c (Lufthansa Group 2019, Ground Handling Procedures in Ground Operations Manual). ULD configuration comes from a/c specifications which can be obtained from Aircraft Type Manual (ATM) (2019) of Lufthansa Group. (See Table 11.)

Regarding LH's operational schedule, it is divided seasonally: by winter and summer time. Winter time starts on the last Sunday of October and ends on the last Sunday of March every year. From April till the end of October, summer operational schedule is in work. This fact above is crucial because demand in air cargo and passenger traffic varies according to the season (will be elaborated and proven later in the current thesis).

[redacted]LCAG: operating performance

Current thesis focuses mainly on cargo segment of airline business. Basically, that is why this chapter is going to discuss LCAG operating performance only.

LCAG represents a logistics business segment of Lufthansa Group. Logistics share of revenues comprises only 7%, which equals €2,713 million in 2018, of the whole amount of revenues (Lufthansa Group 2018, 3—4). What is more, LCAG revenues rose by 7% compared to 2017 (€2,524 million). Yields also increased by 8.6%, after adjustment for exchange rates, in 2018 (28.5 cents in 2018, and 26.7 cents in 2017). To clarify, yields for LH are computed by dividing operating revenues by kilograms of cargo transported. (ibid., 56.)

Unfortunately, expenses rose by 8% in 2018. In 2017, total operating costs for logistics business segment comprised €2,357 million while in 2018 this amount was equal to €2,538 million. The breakdown of LCAG's operating expenses can be observed in Figure 10 below. (ibid., 53.)

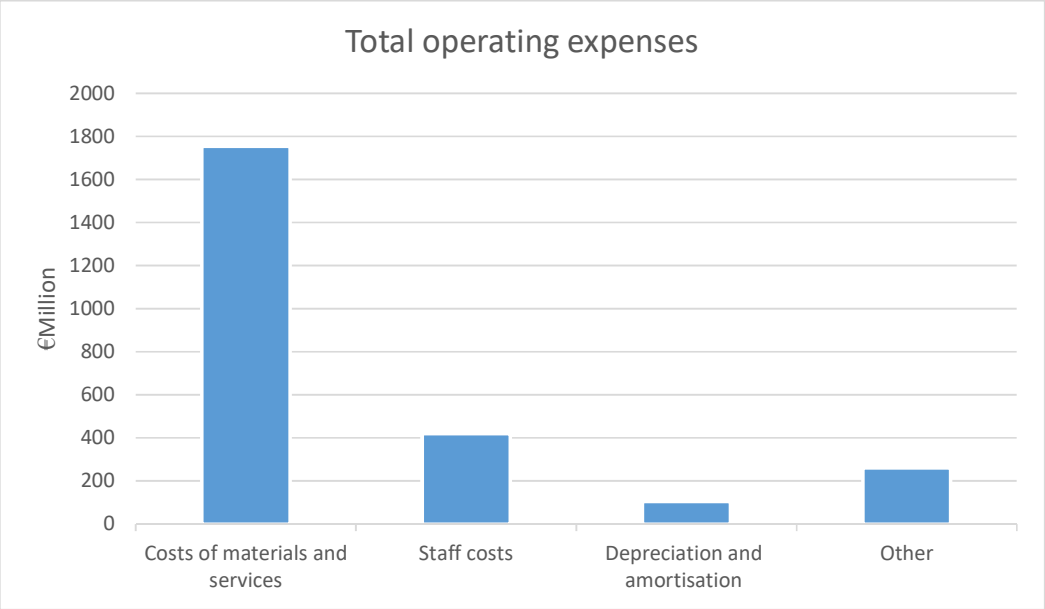

Figure 10. LCAG - Total operating expenses 2018 (adapted from Lufthansa Group 2018 Annual Report)

Costs of materials and services account the greatest part of overall operating expenses of LCAG that contain expenses on fuel, fees, charter and MRO services.

Therefore, profits gained from Logistics segment account €175 million. For comparison, the total profit of Lufthansa Group equaled to €2,163 million in 2018. Cargo business produces 8.1% of profit to Lufthansa Group on the whole.

3.4 Methodology

Methodology chapter is going to plot out the plan for the current study – which steps have to be taken, in what sequence and what are the methods used while conducting the steps.

First of all, as it has been already mentioned and elaborated previously in chapter 3.2, demand study has to be performed. With this reason, the next chapters 4.2 and 4.4 are going to discuss trends in Lufthansa's air cargo and passenger businesses in Saint Petersburg (LED).

According to Render, Stair and Hanna (2012, 175), forecasting methods can be classified in three categories: time-series models, causal models, and qualitative models. Time-series uses background data to draw up future predictions. Causal models analyze factors which can influence on forecasted figures. These two models are quantitative models that are carried out based on historical data. Qualitative models are built up with the regard to judgments and expertise of professionals concerning a defined problem. Usually, qualitative methods are used when the statistical data cannot be obtained. In our case, data is provided. Thus, quantitative method based on *time-series analysis using multiplicative model with trend and seasonal components* has been applied to the air cargo and passenger traffic statistics of Lufthansa/Lufthansa Cargo. As no previous demand study and forecast has been made for Lufthansa/Lufthansa Cargo at LED, the analysis and respective forecast are constructed.

Time-series formula which is going to be used in this study is presented below:

$Demand = T \times S \times C \times R$, where

Demand – Time-series data;

T – Trend component, a certain upward, stable or downward linear pattern over time;

S – Seasonal component, a certain pattern of demand variation which repeats through a defined period of time;

C – Cycle component, certain patters which occurs annually (excluded in our case);

R – Irregular component, an unusual or unexpected variations in the data.

Historical data (monthly observations), which is going to be used for further forecasting, is presented for arriving and departure Lufthansa's passenger business segment for 2016—2018 period. Same is presented for Lufthansa Cargo (LCAG) and Cargo Terminal Pulkovo (CTP) for import and export cargo for 2016—2018 and 2017—2018 periods respectively.

Firstly, in order to make the forecast for 2019, *simple moving average (SMA) approach* is going to be applied to extract seasonal, trend and irregular components from the data given, and which is going to be calculated according to the formula below:

$SMA = \frac{\sum demand\ in\ previous\ n\ periods}{n}$, where

Demand in previous n periods – Time-series data;

n – Number of observations.

Ali, Babai, Boylan and Syntetos (2015, 1756—1761) claim that *SMA approach* is the most well-known and practical ones among the other forecasting methods as it shows the accuracy which can be compared to, for instance, Single Exponential Smoothing. However, *SMA* is better not to be used when clear seasonality and/or trends are observed.

Additionally, when the cycle is decided to be an even number and the trend is present, *centered moving average (CMA)* has to be computed next. *CMA* is calculated by averaging the last two numbers computed by *SMA* calculation. Then, the process of excluding the trend, irregular and seasonal components starts and is called decomposition. *Seasonal indices* are calculated in the first place to extract trend component. Afterwards, *deseasonalization* is to be taken next with the help of *simple linear regression (SLR) model using Excel Spreadsheet Data Analysis Tools*. *SLR analysis*, which uses dependent and independent variables, aims to test whether there is a specific dependence between dependent and independent variables and their influence on one another. Afterwards, an estimated value of dependent variables can be determined (Permai & Tanty 2018, 671—677).

Lastly, forecast is made by minding seasonal factors and trend components. The final forecast is planned to represent air cargo and passenger volumes for 2019. To conduct *time-series analysis using multiplicative model with trend and seasonal components Excel Spreadsheet Data Analysis Tools* are used on the aggregated data from air cargo and passenger traffic figures. The utilized software significantly simplifies the whole calculation process. Moreover, the forecast made is reflected as the graphs

plotted using *Excel Spreadsheet Chart Tools* later. The forecasted volumes of air cargo and passenger transport are presented in cargo payload and seat capacity.

Every forecast needs to be as accurate as possible for the further considerations to suggest the most suitable solution. To check how truthful the forecast determined is, *mean absolute deviation (MAD*) and *mean absolute percentage error (MAPE)* need to be examined. The formulas used for calculations are presented below:

$MAD = \frac{\sum|Forecast\ error|}{n}$, $MAPE = \frac{\sum\left|\frac{Forecast\ error}{Actual}\right|}{n} \times 100\%$, where

Forecast error = Actual value – Forecasted value;

Actual – Historical data;

n – Number of observations.

The closer are the figures (MAD and MAPE) to zero, the more accurate the forecast is. Moreover, to understand in a full manner whether the forecasted figures are predicted well enough, the observations for the first three months of 2019 are taken for comparison.

The forecasted figures for 2019 are available for further analysis now. The idea is to see how much capacity Lufthansa needs to obtain in order to handle the expected demand. The existing fleet of Lufthansa should have been addressed in order to plan the capacity for the air cargo and passenger demands in 2019.

To decide if the capacity offered is optimal, target load factor (LF) for passenger and air cargo will be computed and considered. According to the already known target passenger and cargo LF, the capacities to be offered are adjusted. LFs for passenger and air cargo are computed according to the formulas below:

$Pax\ LF = \frac{number\ of\ transported\ pax\ per\ year}{number\ of\ fligh\quad per\ year \times number\ of\ seats\ per\ year}$;

$Cargo\ LF = \frac{actual\ amount\ of\ ULD\ for\ air\ cargo\ utulized}{available\ number\ of\ ULD\ per\ fligh}$.

The optimal fleet is chosen then, and its rotation and operational frequency are decided regarding seasonal variations and trend projections.

The last but not least, to justify the choice made, profit calculations have to be conducted. Estimated revenues and costs result in profit generation.

Due to the study constraints, profit calculation is made for cargo side of Lufthansa – for Lufthansa Cargo (LCAG). Costs are taken from Standard Ground Handling Agreement (SGHA) which is contracted between Lufthansa Cargo Aktiengesellschaft and JSC "Cargo Terminal Pulkovo" from January 1st, 2017 till December 31st, 2021. Revenues calculated from average cargo yield per chargeable weight (CWT) for LCAG by using *Excel Spreadsheet Software and What-If analysis tool.* Afterwards, the profits are computed. Formulas which are used for computation are as following:

$Costs = \sum LCAG\ costs,\ Revenues = Cargo\ Yield \times CWT, Profit = Revenues - Costs.$

Therefore, profit gains or losses are reflected as quantitative advantages or disadvantages accompanying factors for the solution suggested. However, it is expected that some serious qualitative pros and cons are going to be presented and fully deliberated.

4 Results

4.1 LCAG: Saint Petersburg (LED) – air cargo market share analysis

There are only three active destinations in Russia: Moscow (DME), Saint Petersburg (LED) and Krasnodar (KRR). This thesis is going to analyze air cargo traffic and available capacity matter in LED airport.

In order to start with the demand analysis concerning station at LED, it is important to look at the local international market share of LH. The market at LED is represented by Cargo Terminal Pulkovo (CTP). In fact, this particular market is relatively small and has its own internal restrictions compared to, for instance, Moscow station (DME). In terms of market vastness, DME accounts to be a bigger one. DME enables to provide its customers with in-Russian customs transit for further transportation abroad (regional goods). LED cannot do the same due to the more restricted local

customs regulations. Therefore, these goods, which are supposed to be sent to another country rather than Russia, are transported to Moscow firstly with the help of domestic carriers and secondly abroad using international airlines. In general, Russian businesses are mostly accumulated around Moscow region rather than the other regions.

Furthermore, some air cargo is transported via two nearest gates to LED – DME (Moscow, Russia) and HEL (Helsinki, Finland). Regional cargo is usually forwarded via DME due to the matter discussed in the latter paragraph. If cargo is oversized or its tonnage is too big to carry on the planes departing from LED, local agents decide to forward it via stations where there is enough capacity available – in our case via HEL. Freighter and truck transport solutions are established at HEL. Operations are handled only on working days.

Surely, LED, due to its restrained capacity, loses a lot of cargo tonnage but, fortunately, these losses do not refer to revenues gained from the cargo transported. While HEL or DME are forwarding the cargo, which cannot be forwarded by LED, revenues from its transportation are coming to LED's account.

According to the station's (LED) internal information records, there were ad-hoc trucks going back and forth to and from HEL till 2010. Truck operation was driven by demand component. By mischance, when cargo demand had started to decline, the necessity of truck's circulation disappeared. The basic reason of cargo demand decrease was caused by the advent of competitors on the local market in Saint Petersburg. To clarify, as long as demand decreases, rates for kilogram transported are rising. Consequently, customers are willing-less to pay for cargo transport service. Thus, the loss of customer requests for transportation leads to demand and revenue reduction.

LH shares an international market in cargo transport at LED. Cargo volumes decreased by 0.78% in import and by 4.06% in export when 2017 and 2018 are compared (see Table 12). Plus, the same table presents LCAG's ranking in the LED market for the past two years of operations concerning import and export cargo to and from LED respectively.

Table 12. Air cargo: Lufthansa Cargo's position in LED international market (adapted from Appendix 1)

	Import	Export
2017	#4 (5.72%)	#2 (20.47%)
2018	#4 (4.94%)	#2 (16.41%)

Still, LH saves its positions in CTP being the fourth in import and the second in export (see Table 12). Meanwhile, LH remains one of the leaders. Among these leaders are the other international airlines (see Appendix 1):

- Emirates Airlines;
- Hainan Airlines;
- Korean Airlines;
- Uzbekistan Airways;
- Sichuan Airlines.

These airlines comprise 72.18% on average in import cargo, 64.22% on average in export cargo and 67.84% on average in total cargo tonnage (see Appendix 1). Then, it is evident that Emirates Airlines, that is overcoming LH and every single carrier at LED, is an unquestionable leader. Besides, it is known that 95% of the whole cargo loaded to Emirates' planes, is the cargo which cannot be loaded to NB a/c of, for example, Lufthansa (CTP Internal source). The idea upon this fact is that Emirates and other operators of WB fleet at LED acquire greater cargo volumes and tonnage.

Emirates airlines are strong competitors at the local market since North and South America, Africa and Europe are serviced by them when oversized cargo needs to be transported. Hainan and Korean airlines are aggressive players when it comes to Asian destinations.

To make a smooth transaction into demand analysis, change between data available from 2017 and 2018 has to be primarily considered. Table 13 summarizes the local trends at LED regarding air cargo transport (see Appendix 2).

Table 13. Local international market (LED) trends, 2017—2018 (adapted from Appendix 1 and 2)

	Cargo Terminal Pulkovo (CTP) — Demand			Lufthansa Cargo (LCAG) — Actual			
	Import	Export	Total	Import	Export	Total	Market share
2017—2018	0.75%	9.83%	2.49%	-13.04%	-11.93%	-12.53%	-1.25%

What is to outline and clarify, before going deeper into discussion of obtained figures, is that air cargo volumes of CTP represent the demand for LCAG while LCAG cargo volumes represent actual cargo traffic at the local international market. Table 13 represents the trends of inclines and declines in local international market. During the past two years there is a really small and hardly noticeable increase in import by 0.75% while export shows the better performance with 9.83% increase. Therefore, an overall growth of 2.49% can be observed, and the pattern that market is expanding, slowly but still, is obviously noticed. While market has been evolving lately, LH has been showing not optimistic figures by all means. Export and import have been suffering from a significant decline of demand in 2017 and 2018. When looking at LH's market share, the fall of 1.25% can be noticed.

4.2 LCAG: Saint Petersburg (LED) – air cargo demand analysis

In order to see whether there is any trend in demand figures, *time-series analysis* has to be performed. In this research, the preference has been given to *time-series analysis using multiplicative model with trend and seasonal components* due to the matters described in methodology (address chapter 3.4). All the steps to be taken and procedure to follow are well-explained in methodology chapter (address chapter 3.4). Lately, the forecast for 2019 has been made and presented with the help of the same approach (see Appendix 3).

Nothing follows an exact and predictable pattern — so that the same can be observed in actual figures of air cargo tonnage of LCAG and CTP for the period of 2016—2018 and 2017—2018 correspondingly. Firstly, the graphs, which show the actual air cargo tonnage, have been plotted according to the data given in Appendix 2. The graphs can be seen further in the same Appendix 2. There are several crucial observations to be mentioned:

1) Forecast:
   a) Exponential smoothing analysis is more accurate method to use for forecasting, but it can be made for one month ahead only;
   b) Twelve-months cycle is decided to be used for SMA because it is concluded to be the most accurate compared to six- and four-months cycle (twelve months cycle MAD is less than six- and four-months cycle MAD);
   c) It is expected that somewhat trend in figures is present, so CMA is applied due to even cycle number and in order to extract this trend component;
2) LCAG:
   a) No clear seasonality is involved from the first sight;
   b) Abnormal peak in export can be noticed in the beginning of 2017 due to increased demand on transporting cigarette filters on a contract basis – almost eighty tonnes of cargo was transported monthly in March and April 2017;
   c) Peaks (import): March-July and December;
   d) Peaks (export): March-June and December;
   e) Import figures are always higher than export in terms of air cargo volumes transported but insignificantly – import/export cargo LFs differ a little;
   f) Most of the cargo is coming from Frankfurt (market in Frankfurt is greater than in Munich);
   g) Most of the cargo is transported to/via Frankfurt (better connections in terms of transit duration and availability);
3) CTP:
   a) A rising trend for export starts from July 2018;
   b) Seasonal peaks are observed in summer-autumn period;
   c) Peaks (import): June-November;
   d) Peaks (export): July-December;
   e) Import figures are extremely higher than export in terms of air cargo transported – LED is a demanded destination for import cargo but not exactly for export.

Peaks are decided and identified based on seasonal indices computed using CMA approach (see chapter 3.4). During the peaks in demand figures, seasonal indices are far beyond the smoothed CMA data. When seasonal indices are lower than smoothed out data then the assigned period is counted as a low season. Besides, it is better to focus primarily on CTP demand figures when the peaks are analyzed. Simply because, if an a/c is changed, capacity will be subsequently enlarged. This will lead to penetration of some percentage of market.

It is important to remember that every forecast has its margin of an error (this matter is going to be deliberated later in this thesis). However, those forecasts help a lot to predict approximate values - in our case air cargo volumes in 2019. The graphs of forecasted values were plotted (see Appendix 2) and can be addressed in Appendix 3. The outcomes of the current forecast are pictured in Table 14.

Table 14. Forecasted local international air cargo market (LED) trends, 2018-2019 (adapted from Appendix 2&3)

	CTP (LED) - Demand			**LCAG – Actual traffic**			
	Import	Export	Total	Import	Export	Total	Market share
2018-2019	3.41%	11.46%	5.06%	4.51%	26.20%	14.52%	0.66%

Demand of import and export cargo is expected to grow with 3.41% and 11.46% respectively. In total, an overall demand upsurge of 5.06% is predicted in 2019. In LCAG turn, its cargo traffic is projected to rise the margins significantly by 4.51% in import and 26.20% in export with 14.52% total growth compared to the previous year of operations. The real forecasted figures are provided in Appendix 3.

According to these figures forecasted (see Table 14), the market share of LCAG is aiming at rise as well (see Table 15). Import and export are going to face a barely seen growth of 0.05% and 2.17% respectively leading to the 0.66% increase in whole. Surely, figures are inspiring, but, at the same time, it is important to understand the fact that the major percentage of growth is going to be taken by LCAG's competitors. If LCAG will be proceeding to operate the same way it does at the moment, the market share of the company will increase insignificantly but the airline will not overpass its competitors in the future.

Table 15. LCAG market share at LED, 2019

	Import	Export	Total
2018	4.94%	16.41%	7.29%
2019	4.99%	18.58%	7.95%
Growth (%)	0.05%	2.17%	0.66%

In this case, if the changes are not made, there will appear a great chance that cargo volumes of LCAG will be absorbed by the stronger players in the same market. The most valuable and substantial point here is that these players – other international airlines – have the bigger capacity to offer to customers. This fact is primarily causing the loss of demand for LCAG. More freight and mail with greater dimensions can be transported in one go. Moreover, competitor airlines influence a lot on the LH air cargo transport figures. For instance, if the number of competitors flights drops, LH's market share will rise due to its available capacity to offer to the potential customer.

Though, before going into details, the passenger demand has to be analyzed in order to see the full picture.

4.3 LH: Saint Petersburg (LED) – air passenger market share analysis

Lufthansa operates at Saint Petersburg Pulkovo Airport (LED) that is 100% owned by the city. LED is the only one airport in Russia which is developed under the Public-Private Partnership Agreement dated by 2010. PPP is a business which is carried out by private and public sectors with the idea of delivering the service with increased quality, profitability and efficiency originally provided by public sector (ICAO 2019, Economic Development).

At LED, the share of domestic and international nonstop destinations is 58 to 61. Thus, it can be said, Saint Petersburg's airport is majorly international than domestic. Starting from 2016, international passenger numbers, with their peak season in June-September, are escalating on average by 21.5% annually. (CAPA 2019.)

Generally, 54 airlines are operating at LED nowadays. Indeed, not all of them fly to Germany, specifically, to Frankfurt or Munich. AS For Frankfurt as a destination, Lufthansa is the only airline which serves the route between Saint Petersburg and Frankfurt. During winter schedule, Lufthansa flies to Saint Petersburg and back to Frankfurt twice daily compared to three flights to Frankfurt daily during summer schedule. Munich destination is different. Here, Lufthansa has a competitor represented by a Russian airline – Aeroflot but operated by Rossija. Rossija has one flight daily and two flights on Mondays, Thursdays and Saturdays (the whole year) to Munich while Lufthansa has two flights daily in the morning and afternoon during summer and one daily flight during winter. (Aeroflot 2019, flight schedule; Lufthansa 2019, timetable & flight status 2019.)

4.4 LH: Saint Petersburg (LED) – air passenger demand analysis

Same *time-series analysis using multiplicative model with trend and seasonal components* is applied to the historical air passenger (pax) data for Lufthansa. Forecast made is presented in Appendix 5. However, before talking about prediction of passenger volumes in 2019, it is needed to analyze observations based on passenger volumes statistics (see Appendix 4):

1) Winter schedule represents low season while summer schedule represents the high ones;
2) Arrival – Peaks in demand (May-September), in traffic (May-September), critical (June-August);
3) Departure – Peaks in demand (April-October), in traffic (May-September), critical (July-August);
4) Peaks are mainly analyzed based on the previous year taking into consideration the year before that;
5) Peaks represent more than 18,000 pax per month while critical ones represent more than 22,000 pax per months;
6) Arriving and departing pax numbers are almost the equal – arriving/departure pax LFs do not differ considerably;
7) Demand is slightly greater than the actual traffic.

Year by year, summer time appears to be a peak season for LH. During this time, number of passengers is doubling compared to the winter time. This fact is obvious due to the increased demand for travelling with vocation purposes. Moreover, the seasonal indices calculated justify it quite well. During the peak seasons, these indices are on average 50% higher than smoothed out CMA data.

Moreover, it is expected that the same pattern is going to repeat itself with the slight variation in the upcoming years. Thus, summer 2019 is awaited to have a great demand on passenger transport. Though, it is still needed to be proven with the help of the chosen forecasting technique.

The conducted forecast is based on the Lufthansa's passenger volumes during the previous years of operations – 2016—2018 (see Appendix 4). Additionally, the graphs are presented to indicate the patterns and deviations along with the forecasted numbers obtained while applying *time-series analysis* using the same twelve-month cycle on the same data (see Appendix 4). Appendix 5, in turn, shows the passenger volumes computed for 2019. In order to see whether there are any changes in demand and traffic passenger volumes, Table 17 was constructed and presented below.

Table 16. Forecasted local international air passenger market (LED) trends (adapted from Appendix 4)

	Arrival pax		**Departure pax**	
Lufthansa	Demand	Traffic	Demand	Traffic
2016-2017	11.09%	12.61%	10.85%	12.52%
2017-2018	-0.14%	-0.62%	-0.87%	-1.20%
2018-2019	5.81%	7.19%	5.03%	6.65%

As the data presented is obtained for the years 2016, 2017 and 2018, the relationship may be observed only between those three. For instance, in 2017, there has been noticed a moderate growth of 11% on average in arrivals and departures of passengers in comparison with 2016. The following year has not revealed any particular or significant changes so the market stayed stable. However, the decline in arrival (-0.14% and -0.62%) and departure (-0.87% and -1.20%) volumes can still be observed when 2017 and 2018 are likened. Other way, the progressive trend is expected to return with the average growth of 6% in arriving and departing passengers in 2019. (Table 16.)

Fleet is going be analyzed next to conclude which type of a/c and its model is the most suitable and accounted to be the “optimal” choice for Lufthansa and its air cargo and passenger demands in 2019.

4.5 LH: Saint Petersburg (LED) – own versus competitor’s fleet and their frequencies

Even with the slight growth in local air cargo and passenger market, Lufthansa does not benefit notably in terms of market share. Thus, the changes should be identified, suggested, and elaborated clearly.

LCAG does not use its own fleet at LED. LH fleet is utilized for cargo transport. Belly capacities in passenger aircrafts of LH are in business.

First thing to be addressed in the current chapter is Lufthansa’s fleet in Saint Petersburg (LED). In reality, LH operates only with narrow-body (NB) fleet at LED. LED’s NB fleet consists of the following a/c models: Airbus A319, Airbus A320 (in a great majority), and Airbus A321. Their characteristics regarding passenger and cargo capacities are presented in Table 11. For the further fleet assignment proposal, only existing fleet of LH is going to be addressed.

As it has been previously mentioned that LED is quite competitive market regarding its cargo side but not much from passenger side of airline business, competitors’ capacities have to be taken into account. For instance, the strongest players which outpace LCAG (e.g. Emirates Airlines, Hainan Airlines and Korean Air) operate wide-body fleet (WB) fleet at LED. This particular detail gives a huge advantage to LCAG competitors – capacity. The more capacity airline offers, the greater amount of cargo it can transport. Surely, it does not mean that this capacity is utilized to the fullest, and it is always a problem for cargo as the market is volatile. However, it does not create a problem to LCAG competitors to lead the market with this type of a/c. Emirates Airlines has two flights (import and export) a day operated by Boeing 777 or Airbus A380. Hainan Airlines flies to LED only three times a week on Wednesdays, Fridays

and Sundays but with Boeing 787 or Airbus A380. As for Korean Air, this airline utilizes only Airbus A330 on Tuesdays, Thursdays and Sundays. What is more, there was even freighter a/c operated by Korean Air till 2017.

All the airlines mentioned above transport passengers and cargo to their hubs (Emirates – Dubai, Hainan – Beijing, Korean – Seoul) which are situated farther than Lufthansa's hubs in Frankfurt and Munich. Additionally, these airlines can carry the same amount of cargo as LH can transport in 2—3 days or so with its NB aircrafts. From this exact point it can be concluded that LH's capacity is far behind the competitor's ones.

Therefore, the logical derivation which comes next is that bigger capacities give an enormous benefit to an airline embodying the greater market share. Simply put, if the larger-capacitated a/c (e.g. WB) flies to the point of destination, the higher market share percentage will be owned. As an example, Emirates Airlines could be taken for the better explanation of the above idea. When the carrier came to the market, it started to operate with WB aircrafts only. This decision made it possible to penetrate the market significantly so that the airline keeps holding its position in there for the last years.

4.6 LH: Saint Petersburg (LED) – schedule

Higher air cargo and passenger demands are projected during summer schedule. For this reason, LH adds two flights for operations at LED comparing to winter schedule. Below, one can see the daily LH schedule: winter and summer (see Table 17 and 18).

Table 17. LH winter schedule

Inbound			**Outbound**		
Flight	**Arr. time**	**Route**	**Flight**	**Dep. time**	**Route**
LH1438	23:00	FRA-LED	LH1439	06:35	LED-FRA
LH2564	16:15	MUC-LED	LH2565	17:20	LED-MUC
LH1436	18:00	FRA-LED	LH1437	19:25	LED-FRA

Table 18. LH summer schedule

Inbound			Outbound		
Flight	**Arr. time**	**Route**	**Flight**	**Dep. time**	**Route**
LH2566	01:45	MUC-LED	LH2567	05:05	LED-MUC
LH1438	22:50	FRA-LED	LH1439	05:55	LED-FRA
LH1432	12:55	FRA-LED	LH1433	14:10	LED-FRA
LH2564	15:45	MUC-LED	LH2565	16:50	LED-MUC
LH1436	16:40	FRA-LED	LH1437	17:50	LED-FRA

Frankfurt, as a destination, is more demanding due to a greater number of connections available. During winter time, 417 flights on average depart from Frankfurt on daily basis while 322 depart from Munich. Summer schedule is more congested. That is why Frankfurt has on average 427 flights daily and Munich has only 330 flights. (Lufthansa 2019, timetable & flight status.)

LH is aware of the fact that there is a considerable passenger growth of demand during summer periods. Moreover, it is clearly seen from time-series analysis which is even projected to 2019. The same trend is planned to be observed during summer 2019 (see Appendix 2 and 3). Thus, it is obvious that airline tries to expand its capacity by increasing the flight frequency during summer in order to meet the predicted demand upsurge.

The current schedule has not been changed due to well-established connections for more than twenty years. For instance, morning flights are supposed to catch connection flights to the US and afternoon/evening flights have to catch European destination connections. The schedule is well-thought out and constructed with the regard on passenger volumes and its demand fluctuations. With this schedule passengers can catch their flights as well as the waiting time between connecting flights is minimized. Apparently, if the schedule change is going to be suggested, LH most likely will not accept it. Thus, schedule adjustment or frequency change are not the subjects to discuss due to the matter of practicality.

However, due to the latest update, from the 1st of May 2019, flight number LH2567 is going to change the slot. The arrival is planned at 07:35 and departure at 08:40 from Monday to Friday. The reason is that competitors have booked the time slot which used to be LH's. Therefore, LH demand will be probably influenced by this change, and a number of the customers will be lost because some of the connections will not be met. (LH Internal source.)

4.7 LH/LCAG: Saint Petersburg (LED) – proposed solution

When forecast has been made and the following factors have been considered (e.g. fleet availability and schedule restrictions), the optimal solution has to be suggested and discussed. To start with the proposal, the load factors (LFs) from air cargo and passenger sides of LH business should be computed and deliberated.

As it is impossible to find target load factors or gather it from any reports at LED, they have to be calculated. The target LFs are computed by assuming that present LFs are suitable for LH with the current schedule and frequencies using the existing fleet composition. The average target LFs are calculated based on formulas in chapter 3.4, and the obtained results are presented in Table 19.

Table 19. Passenger and air cargo load factors and capacities at LED

		PAX	CARGO	
2016-2018	**Target LF**	81.5%	11.1%	53%
	Average Capacity	174 seats	3000 kg	1.59 = 2 ULDs
2019 (predicted)	**Predicted LF**	88.1%	12.9%	61%
	Predicted Capacity	184 seats	3476 kg	1.83 = 2 ULDs

Target LF for passengers (81.5%) is positively high compared to the average LF in Europe of 76.5% for LH (see Table 11) but does not reach the average of 84% for all airlines operating worldwide (see Table 4). Although, cargo LF is dissatisfying with its 11.1% (see Table 20). Such a low cargo load factor can be explained by the fact that the amount of transported cargo in kilograms is less than its chargeable weight (CWT). Fortunately, it does not mean that LCAG does not utilize the full capacity. In reality, there can be not much cargo to transport in kilograms but the ULDs utilized with the cargo may occupy the whole capacity offered because of the actual dimensions of cargo. Therefore, information about actual ULD load is required. To compute cargo target LF, the Load Instruction Reports (LIRs) for period of March (one of the months in high season for cargo) and July (midsummer month of possible WB operation) are studied. The average LF for cargo is computed to be 53%. Thus, almost two ULDs are utilized for cargo on each flight.

Due to the fact that Airbus A320 model of a/c is in a great operable majority at LED, the corresponsive figures of 174 passenger seat capacity and 3000 kilograms of cargo capacity on average are considered for further LF computation (see Table 19). As the demand study has been already executed and demonstrated the growth both in passenger numbers and cargo kilograms in 2019, the LFs with the same fleet assignment have to rise too. Assuming that the fleet stays unchangeable, passenger LF will be equal 88.1% which is 6.2% higher than the target LF for passengers. With the predicted passenger traffic growth, the seating capacity should be consequently enlarged from 174 seats on average to 184 seats in 2019 to meet the projected increase of demand. Same for cargo component - the LF is projected to rise along with the capacity.

Next step is to address LH fleet presented in Table 11. Passenger side of LH is to be discussed firstly, and the fleet assignment should be done primarily with the regard to its demand fluctuation. The reason behind it is covered by the fact that the majority of revenues for LH, as a FSC, is coming from passenger transportation. This point is clearly explained in chapter 3.2.3. Moreover, the accuracy of air passenger demands is more precise than the same for air cargo (is to be discussed later in the next chapter).

Winter is accounted to be a low season in terms of passenger transportation. To maintain the target passenger LF calculated, the following models of a/c have to be utilized at LED:

1) Airbus A319 (138 seat capacity);
2) Airbus A320 (168 seat capacity).

Therefore, with those a/c in operation during winter schedule, the passenger LF of 87.7% can be achieved.

Concerning summer schedule (peak season), the situation is different. Airbus A319 is not suitable anymore due to its 138-passenger seat capacity. However, these a/c models presented below have to be used:

1) Airbus A320 (168 seat capacity) and Airbus A320 or Airbus A320neo (180 seat capacity) for the whole summer period with the increase of passenger LF to be equal to 91.7%;
2) Airbus A320 (168 seat capacity) and Airbus A320 or Airbus A320neo (180 seat capacity) which are NB aircrafts, and WB a/c model Airbus A330 (216 seat capacity) are expected to increase passenger LF to be equal 86.3% during June-August (peak months in high season).

Thus, the aircraft models that can be utilized on their fullest are:

1) NB: Airbus A319 – 30 in stock;
2) NB: Airbus A320neo - 18 in stock, 67 on order (confirmed) - if not available then A320;
3) NB: Airbus A321 - 63 in stock;
4) WB: Airbus A330 - 17 in stock.

As it has been already mentioned and justified not to adjust the established schedule, the number of flights and times are not going to be altered (see chapter 4.6). Therefore, the fleet assignment for winter and summer schedules reasonably explained is presented in Table 20 and 21 respectively.

Table 20. Winter schedule with fleet assignment 2019

Winter Schedule	A/C type and model	Reasoning

Frankfurt (early morning & evening)	NB: Airbus A320 or Airbus A320neo	• Greater demand in the mornings and evenings - passengers fly more from 8—9am and 5—6pm (see chapter 3.2.4); • Frankfurt needs bigger NB because has more connections than Munich (417 to 322).
Munich (afternoon)	NB: Airbus A319	• Munich is the second hub, so it has lesser connections; • Lesser demand in afternoon.

Table 21. Summer schedule with fleet assignment 2019

Summer Schedule	A/C type and model	Reasoning
Frankfurt (early morning)	NB (WB): Airbus A321 (Airbus A330 in June-August)	There is definitely a need to have WB a/c in this destination during summer but only whilst June-August months due to: • Passenger demand is on peak in June-August; • Greater demand in the mornings; • More connections are met (FRA – 427, MUC – 330); • The last flight on arrival and the first one to departure: all the late arriving passengers and cargo are booked on this flight; • Ground times for WB a/c are longer than for NB a/c so that is why overnight flight is chosen.
Munich (early morning)	NB: Airbus A320	• Greater demand in the mornings; • Munich is the second hub, so it has lesser connections.
Frankfurt (afternoon)	NB: Airbus A320 or Airbus A320neo	• Frankfurt needs bigger NB because has more connections than Munich (427 to 330); • Lesser demand in afternoon.
Munich (afternoon)	NB: Airbus A320	• Munich is the second hub, so it has lesser connections; • Lesser demand in afternoon.
Frankfurt (evening)	NB: Airbus A321	• Greater demand in the evenings; • Frankfurt needs bigger NB because has more connections.

The above decision upon the fleet assignment is made mainly based on passenger demand figures for 2019. To enclose the solution proposed, air cargo demand forecast has to be considered. Peak season for cargo is accounted to fall into the limits of summer schedule - June, July and August – and winter schedule – December. Since passenger demand in December is rather low, it is unnecessary to utilize WB a/c during this month, while June-August months are peak time both for passengers and cargo demand. Thus, it is concluded to have WB a/c operated only in June, July and August on a daily basis. The flights which are chosen to be operated by WB a/c are LH1438 (import, late night departure) and LH1439 (export, early morning departure) due to several aspects. As LH1438 is the last one departing flight from FRA daily, all left passengers and cargo are collected and loaded on it. LH1439, the early morning flight, has more passengers and cargo from the previous day collected and loaded on it. Moreover, WB a/c type is suggested only for FRA destination due to the greater number of connections in FRA hub airport.

Consequently, the fleet composition stays rather the same as it is nowadays. The only difference is that WB a/c is supposed to operate just during summer schedule and for a couple of months (June-August). During the rest of the time, NB fleet remains to be utilized.

[redacted]LCAG: Advantages and disadvantages upon the decided option

Every single decision has its pros and cons. In order to decide whether the proposed solution is worth to be considered by the airline, positive and negative factors should be studied. Advantages and disadvantages of the proposal can be presented in two ways – qualitative and quantitative. The distinction between these two is discussed in chapter 3.4 while studying the forecasting methods.

There are few weighty qualitative advantages that are following the chosen fleet assignment option. Among those are:

1. Flexibility in cargo transport;
2. Cargo capacity enhancement;
3. Advanced cargo commodities;
4. Shorter transit times.

Flexibility in cargo transport reflects flight frequency and a/c rotation of LH compared to its competitor's frequency. For instance, the frequency of WB a/c operated by LH is the same compared to Emirates airlines, but the main advantage is in overall frequency. LH will be having five flights a day during summer: one of those is planned to be operated with WB a/c while the other four are operated by NB a/c. Customer will be able to choose the most preferable flight, if the cargo is loadable both on NB and WB a/c types. Thus, there is more freedom to choose and greater chances to be transported in time for customer.

Cargo capacity is going to be enlarged during the peak months (June-August) when the WB a/c is planned to be utilized for operations at LED. Therefore, more capacity can be suggested to customer compared to the competitors due to the change of NB a/c to WB ones. Additionally, there are four more NB aircrafts with lesser cargo capacity that can be used in emergent cases.

Oversized and big dimension cargo will have an opportunity to be transported due to capacity enhancement. If cargo fits in WB a/c only then there will be daily WB operated flight flying from/to FRA. This advantage gives LH more chance to get potential revenues for the cargo moved.

Transit times are expected to be shortened due to the closer LH's hub location in FRA. Emirates, as it has been already mentioned, has its hub airport in Dubai (DXB). Cargo is firstly moved there to be consolidated with the other shipments and directed further if needed. LED is closer to FRA than to DXB. Consequently, there appears more possibility to meet the connections and to reduce transit times in terms of both air passenger and cargo transport.

However, some disadvantages are also the subjects to exist. One of the main qualitative disadvantages is the chance of not being able to sell the added capacity due to customers' unacquaintance or unsureness of new service provider. It may happen that customers will not want to change their air cargo service provider that utilizes WB a/c.

Quantitative benefits and losses, if there are any, are mostly described in financial matters of this case. The next chapter is going to discuss those in a full and constructive manner.

4.8 LCAG: Saint Petersburg (LED) – operating performance

According to the work done, fleet type is not expected to be changed completely. Thus, operating performance for the whole winter-time schedule will not have any significant variations. Though, since change of an a/c type is only projected for the period of June-August 2019 during summer schedule, the operating performance for this exact period will be affected.

In order to calculate the profit which may be gained from new a/c assignment, costs and revenues should be presented in the first place. It is decided to check whether the change applied can reach breakeven at least. Thus, costs have to be equal to generated revenues.

Since this thesis is primarily focused on cargo segment of airline business, all the calculations are based on LCAG expenses and revenues only. Additionally, cargo costs include expenses from LH which cover ground handling of cargo at ramp in the airport. Cargo ground handling service is provided by CTP. Moreover, there is only one ground handling provider which defines monopoly at LED.

Starting with the costs, tonnage predicted with time-series analysis for the period June-August is considered. Export and import cargo figures are studied together. Mail tonnage is expected to stay the same because of the package which is used according to airline requirements for transportation. Therefore, mail is not influenced by a/c type change. Besides, Standard Ground Handling Agreement (SGHA) and previous LCAG invoices from CTP are analyzed, and the costs division and definitions are presented below (see Table 22) with the respective percentages from the total cost.

Table 22. List of cargo expenses

Invoice party	Cost	Percentage from total
LCAG (44.6%)	Storage of standard cargo (import/export) acc. Agreement	0.1%
	Charge for return of cargo (mail) from the aircraft upon Carriers representative request	0.2%
	Forming and sending an electronic message to the customs authorities	2.9%
	ULD Transportation and Storage acc. Agreement	3.1%
	Cargo handling - 5 section - acc. Agreement	19.7%
	Mail handling - 5 section - acc. Agreement	7.5%
	Special cargo handling - 5 section - acc. Agreement	11.0%
LH (55.4%)	Ramp Handling - 6 section (A320) acc. Agreement	24.7%
	Ramp Handling - 6 section (A321) acc. Agreement	8.8%
	Ramp Handling - 6 section (A330) acc. Agreement	22.0%

From LCAG expenses, general and special cargo and mail are accounted to form the main cost part while ground handling of Airbus A320 and A330 form the main cost part for LH (see Table 22). Consistent with SGHA, prices for servicing WB and NB a/c differ by 2.5 times for just one turnaround at LED (see Appendix 6). Prices are greater for WB due to several reasons. For instance, ground times are longer for WB, service is more complicated, more work force is involved, enhanced maintenance requirements and etc.

With an a/c type change, the share in cargo market is expected to grow. Employees at LCAG station at LED, with their expertise, assume that the share in export will rise by 5% at the lowest in local market and by 10% in regional market (Moscow (MOW) included). For comparison, MOW market is approximately ten times bigger than LED market. Likewise, import figures are supposed to rise by 50% in total. These percentages are quite realistic because they are set at the minimum. The tonnage which is

predicted to be can be addressed in Appendix 7. The costs that correspond to the cargo tonnage predicted are presented in Appendix 8.

To breakeven, expenses have to be equal to revenues generated. CWT and cargo yields are needed for revenues computation. While yields are collected from the past statistical reports 2017-2018, CWT cannot be gathered from anywhere. Thus, the question arises – what is the CWT to have to breakeven? The obtained results can be addressed in Appendix 9.

Therefore, 129,896 kilograms of CWT are needed to be transported in order to reach the breakeven point. Breakeven point, in that sense, can be achieved even during the first month of WB a/c operation at LED. Additionally, due to a greater quantity of kilograms projected for June-August 2019, even some profit can be generated. This profit accounts to exceed the present one by 200% (double greater than the present).

With the positively expected profit generation, which is referred to as quantitative advantages, cargo load factors are likely to fall. Obviously, this can happen due to the capacity enlargement with the use of WB a/c at the current destination. LFs for only WB, not taking into consideration NB a/c cargo capacity, are as follows:

- 46% - June;
- 43% - July;
- 42% - August.

Fortunately, with low yields for WB still, more customers will be interested in new and fresh-opened opportunity for transportation. Thus, LFs are possibly to be risen. Moreover, with the bigger a/c, cargo yields can be increased by the airline as well. Even though the demand is planned to stay or grow. The basic reason for this is that airlines which operate WB fleet are in minority. Subsequently, the competition is not so aggressive as between NB operator airlines. However, it is better to start with the present cargo yield in order to attract more customers, and only then to slowly increase it.

5 Discussion

5.1 Answers on research questions

The research questions which had to be answered with the proceeding of current thesis were stated as following:

1) What aircraft fleet assignment can be applied for Lufthansa/Lufthansa Cargo in Saint Petersburg (LED)?
2) What flight frequency should be applied be at LED?
3) What are advantages and disadvantages of the proposed fleet assignment?

In order to draw up the definite conclusion, the every above research question needs to be given an answer with the clarification.

1 – What aircraft fleet assignment can be applied for Lufthansa/Lufthansa Cargo in Saint Petersburg (LED)?

Time-series analysis of passenger and air cargo demands and, based on it, respective forecasts were constructed. Forecast accuracy was also measured – MAD and MAPE were calculated. Due to air cargo market instability and unclear seasonality, its forecast accuracy showed worse results than the passenger forecast ones. Table 23 demonstrates the precision of the forecasts made.

Table 23. Forecast accuracy

	Air cargo (kg)				**Air passenger (pax)**			
	LCAG		CTP		Arrival		Departure	
	Export	Import	Export	Import	Demand	Traffic	Demand	Traffic
MAD, kgs or pax	7373,42	9641,59	29780,80	66270,23	732,60	798,63	733,25	753,85
MAPE	21.5%	23.5%	13.8%	7.9%	4.2%	4.7%	4.2%	4.5%

The closer precision of air passenger forecast resulted in building up decisions according to passenger side of business and its fluctuations apart from cargo (see chapter 4.7).

With the regard to the study done, it was decided that there was no need in a/c type change. However, Airbus A330 (WB a/c) was matching passenger LF at LED but only during summer schedule for a couple of months (June-August) and on route FRA-LED-FRA. Therefore, it was decided to give this a/c, to be operable at LED, a try. While passenger LFs were considered with this change, cargo LFs were not since it was impossible to predict how customers would act on LH's capacity enlargement. It is still unknown how much growth is planned to be observed. Thus, there are only estimations and assumptions of any possible market share increase which is awaited by LCAG personnel. The expectations of market share growth are clearly deliberated in previous chapter (see chapter 4.7).

What can be proposed in this case is that LH can attempt to employ WB a/c at LED destination on the trial mode. For instance, Airbus A330 can be send to LED during June-August period this year to see whether this kind of change is worth establishing. Trial can be performed by reassigning the aircraft models in existing fleet or leasing the needed models of a/c. Leasing can be executed with the help of the cooperative airlines of Lufthansa Group or within the same alliance – Star Alliance. If the result is disappointing and does not meet expectations, the plan of new fleet assignment will not work out at its best manner and will be reviewed.

2 – What flight frequency should be applied be at LED?

Flight frequency will not be changed due to established airline's schedule construction (address chapter 4.6). Therefore, it was decided to change only an a/c type, in existing fleet, on the route FRA-LED-FRA without adjusting departure and arrival times.

3 – What are advantages and disadvantages of the proposed fleet assignment?

The suggested solution has a number of advantages and disadvantages which are clearly and precisely explained in the previous chapter (see chapters 4.7 and 4.8).

Moreover, the proposed option's pros and cons are observed from different perspectives: qualitative and quantitative. The below Table 24 summarizes all the advantages and disadvantages regarding the option offered for reviewing.

Table 24. Solution's respective advantages and disadvantages

Qualitative		**Quantitative**	
Advantages	Disadvantages	Advantages	Disadvantages
Flexibility in cargo transport	A chance of not being able to sell and utilize the added capacity	Rise in air passenger load factors	Fall of cargo load factors
Cargo capacity enhancement		Double greater profit from cargo transport	
Advanced cargo commodities			
Shorter transit times			

5.2 Suggestions for the future studies

Due to the fact that forecast accuracy for air cargo leaves much to be desired since its market is rather volatile compared, for instance, to air passenger demands, further study needs to be carried out to draw more concrete conclusions. As a suggestion, other analysis methods, taking into account a greater number of variables, might be selected for forecasting air cargo and passenger demands at LED to decrease the error margin. Other option, as it has been laid out before, a recommendation for trying to deploy test flights on the route FRA-LED-FRA is also possible to realize. The outcomes of the last proposal may give a greater precision results rather than conclusions based on demand forecast. However, the outcomes are unknown, and there is a chance of incurring losses still.

6 Appendices

Appendix 1. Air cargo market shares, 2017-2018

Appendix 2. Actual air cargo tonnage (kg), 2016-2019

Appendix 3. Air cargo Forecast (kg), 2019

Appendix 4. Air passenger numbers, 2016-2019

Appendix 5. Air passenger numbers forecast, 2019

Appendix 6. SGHA, page 3

Appendix 7. Air cargo forecast for June-August 2019 concerning a/c change

Appendix 8. Cargo costs, June-August 2019

Appendix 9. LCAG operating performance, June-August 2019

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